WATER WORKS & SEWERAGE

E. S. GILLETTE, Publisher

L. H. ENSLOW, Editor

ARTICLES AND AUTHORS Scheduled for Future Issues

"Developments in Sewerage and Sewage Treatment," to appear in February, constitutes a review of progress in sewerage and sewage treatment during the year 1935, by Samuel A. Greeley, well known Consulting Engineer of Chicago.

"Operating Small Water Plants"—by C. van den Berg, Pres., W. Va. Water Service Co., Charleston, W. Va., recounts experiences and methods of construction, operation and maintenance of small water works properties, which have led to economies and improved efficiencies.

"Operating Kinks"—A. M. Rawn, Ass't. Chief Engr., Los Angeles County Sanitation Districts, and President of the California Sewage Works Association, constitutes a follow-up article to his previous contribution, "Sewer Cleaning with Rubber Beach Balls," which appeared in WATER WORKS AND SEWERAGE for October 1935. In the forthcoming article, Mr. Rawn describes several useful "Kinks" employed in sewer maintenance and plant operation, under his supervision.

"Methods of Treating Milk Wastes and Milk Products Wastes"—by L. F. Warrick, State Sanitary Engineer of Wisconsin, describes practical methods utilized in treating milk wastes in Wisconsin, results secured and costs.

"Practical Problems in Water Distribution"—by E. W. Breitkrentz of Los Angeles, constitutes a discussion of experiences in construction, repair and operation problems in the Los Angeles Water Department.

"Garbage Disposal via Sewage Treatment" is a subject of considerable current interest. Cecil K. Calvert, Engineer-Manager of Waste Disposal Plants, Indianapolis, Ind., will disclose the results of large scale experiments, wherein ground or shredded garbage has been put through the Indianapolis Activated Sludge plant in varying quantities.

"Dry Feeding of Chemicals"—by R. W. Fitzgerald, Sup't. of Filtration Plants, Norfolk, Va., discloses experiences with the adaptation of a variety of chemical feeders for various duties during the past 3 years. Comments and suggestions of a practical nature are to be found in Mr. Fitzgerald's valuable article.

"A New Method of Applying Copper Sulphate to Reservoirs" is to be described by R. F. Goudey, Engr., in Charge of Water Quality, Los Angeles. The scheme involves the use of pulverized sulphate of copper and a broadcasting dry-feeder located in the stern of the boat. The method has proved labor saving, more economical, more uniform and efficient than the bag or spray methods.

"Scale and Corrosion Control in Aqueous Systems"—is to be dealt with by D. W. Haering, Chemical Engineer of Chicago, Ill. The most effective modern water corrosion control practices and the application of corrosion inhibitors will be discussed.

"Determining the Required pH in Corrosion Control"—by Philip L. McLaughlin, San. Engr.-Chemist, West Virginia Water Service Co., reveals a procedure effectively used to determine for various waters the proper and economical pH adjustment in the control of corrosion.

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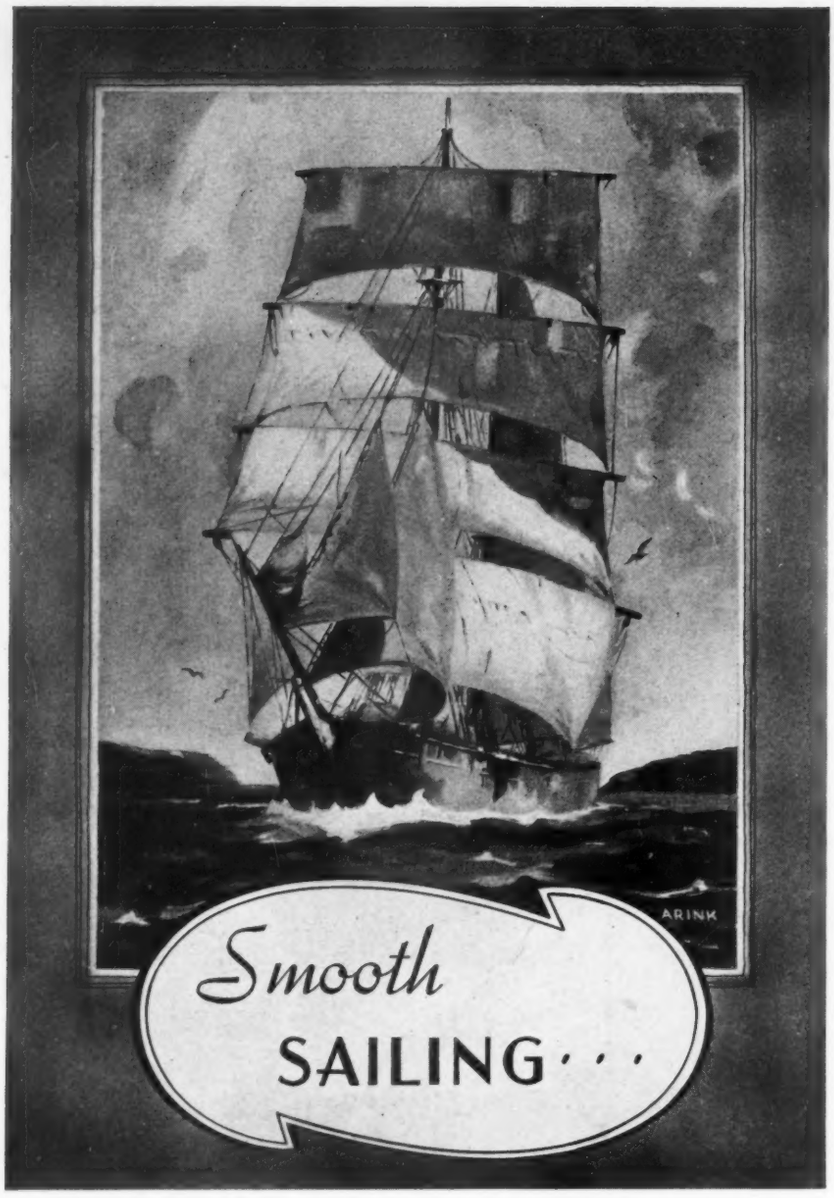

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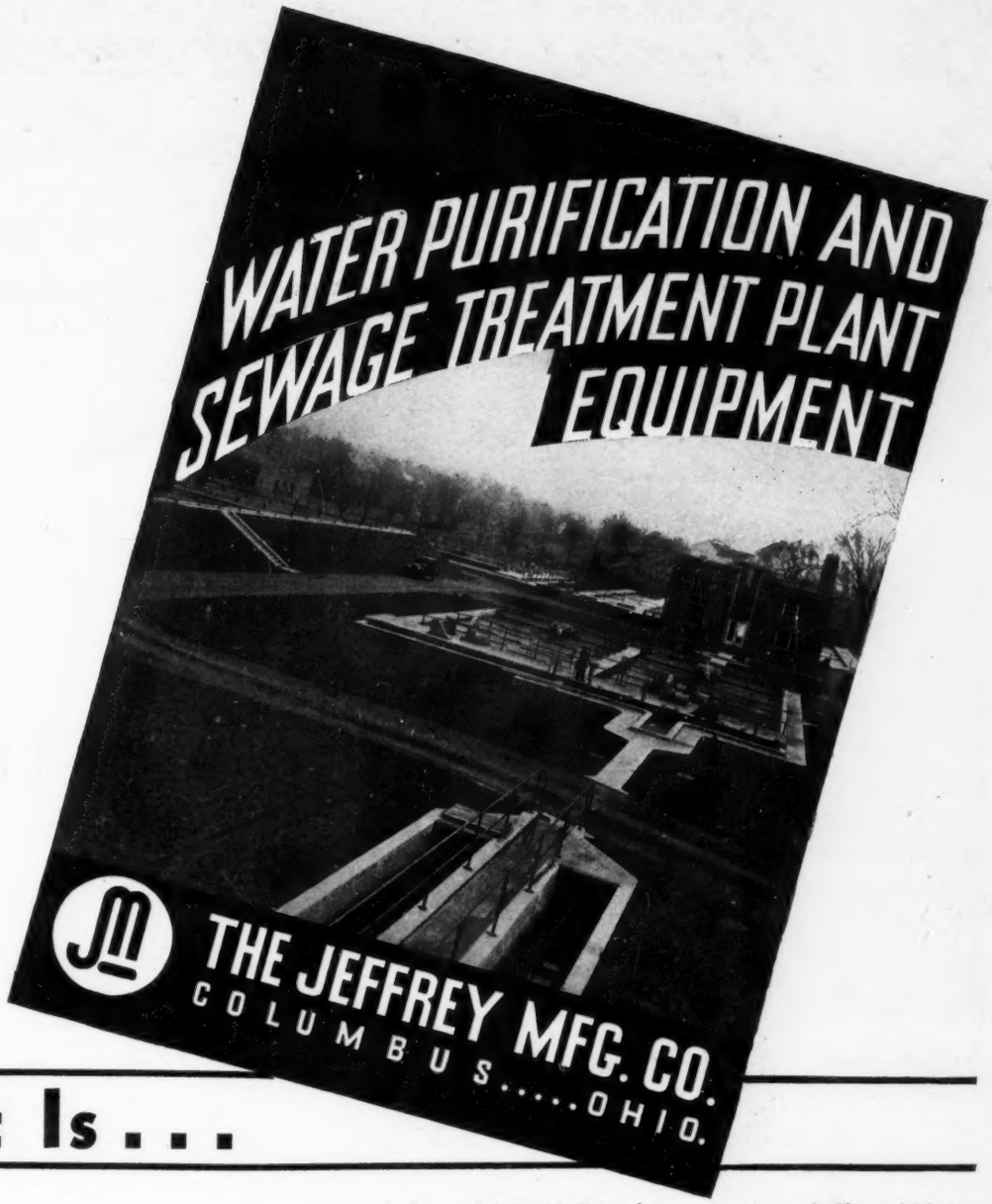

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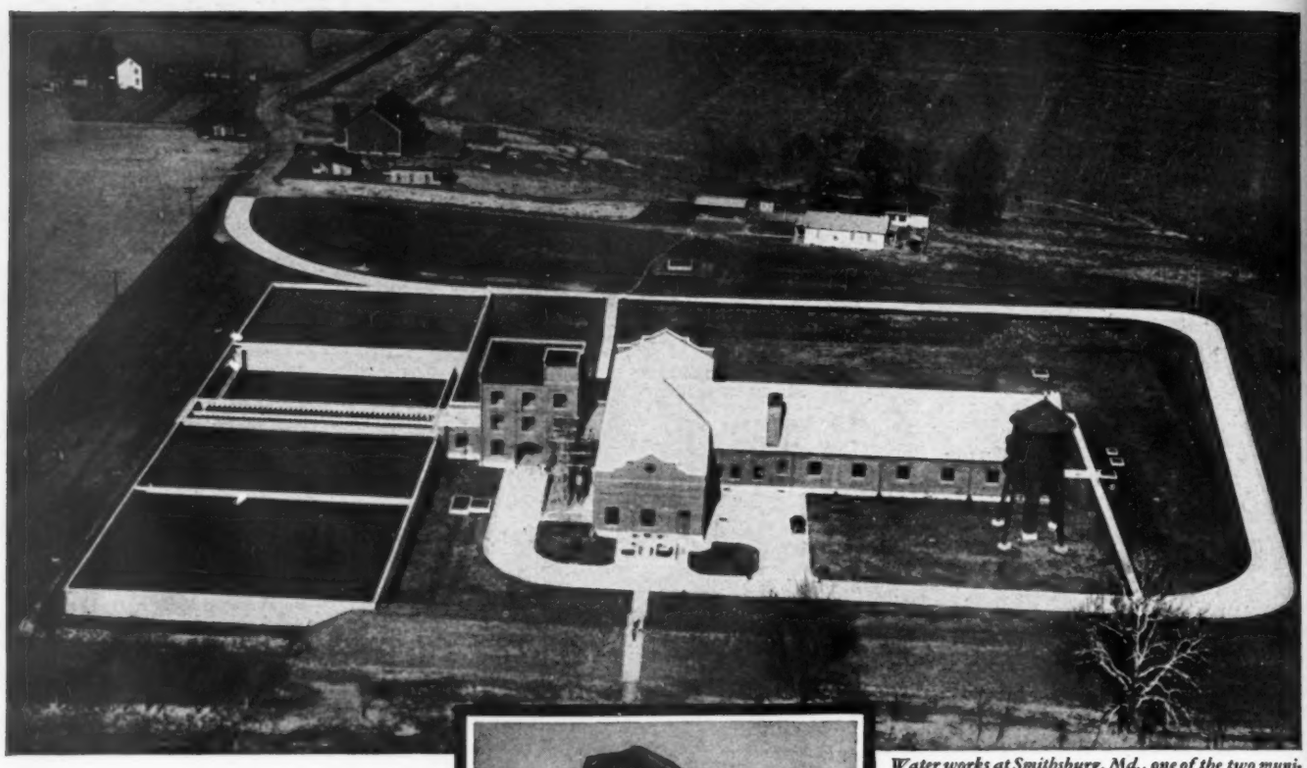

Water works at Smithsburg, Md., one of the two municipal water plants supplying the City of Hagerstown.

Hagerstown, Maryland, long a satisfied user of both Mathieson Chlorine and HTH

IT is only natural that water works officials, upon whose shoulders their communities place such heavy responsibility, should appreciate pure chemicals, trouble-free equipment and dependable deliveries. That they do appreciate these things and that they place their business accordingly is shown by the tribute to Mathieson Chemicals expressed by Albert Heard:

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(Left) Albert Heard, Secretary of the Board of Water Commissioners, Hagerstown, Md.

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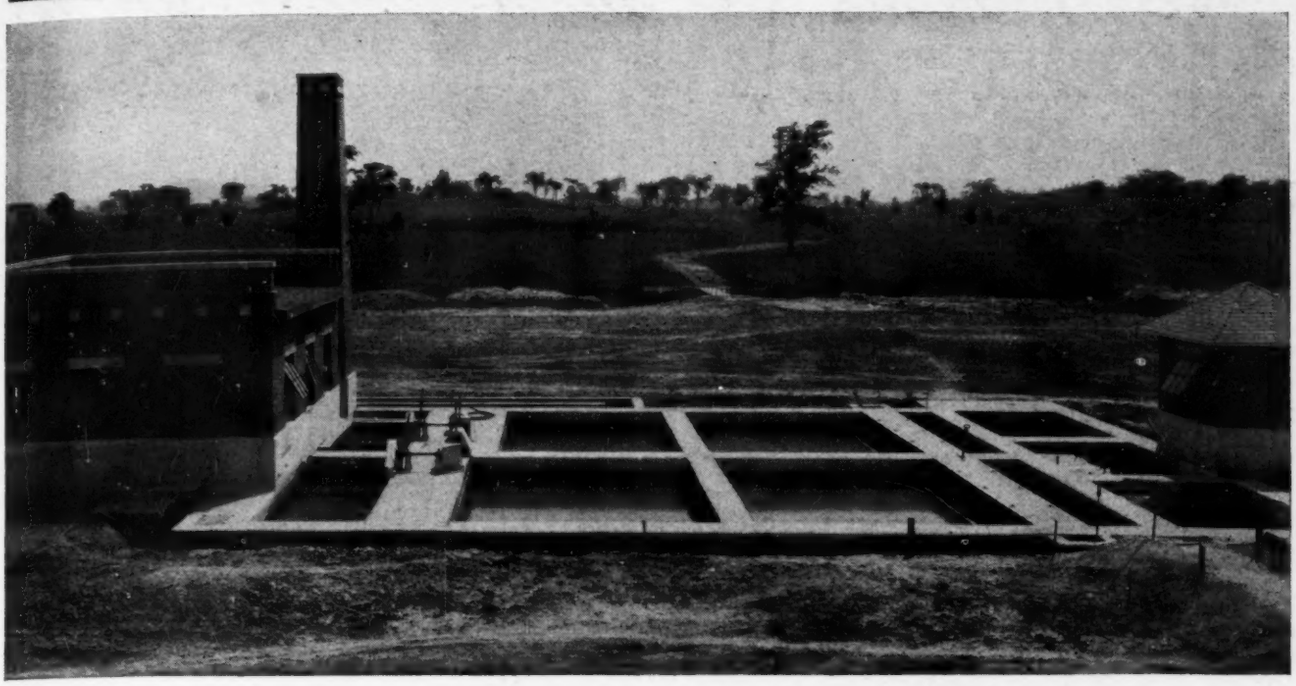

St. Albans, Vermont Sewage Treatment Plant. Henry W. Taylor, Consulting Engineer, New York City. Post-aeration tank employing Aloxite Brand Diffusers at right.

Post-aeration provides an important improvement in Partial Sewage Treatment

FOR example, consider this ideal plant at St. Albans, Vermont—incidentally the first sewage plant in that state to use aeration. The brook, into which the effluent discharges and which becomes practically dry in summer, empties into Lake Champlain a few miles away.

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"Use of Chemicals in Sewage Treatment": We have prepared reprints of this article by Mr. Ralph A. Stevenson in a recent issue of "Western City," outlining in non-technical terms some of the standard practices and recent developments in chemical treatment. We'll gladly send copies on request to any community officials who wish copies.

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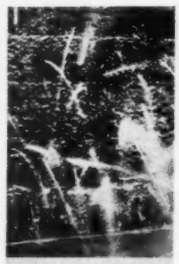

1 Original surface hacked.
2 Water concentrated to enlarged bleeder holes by Sika #4A.
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4 Inserting Sika #2 into last bleeder hole.
5 All bleeder holes plugged with Sika #2, and trimmed to contour.
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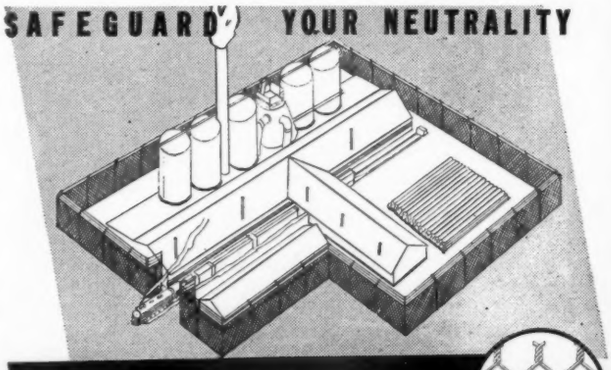

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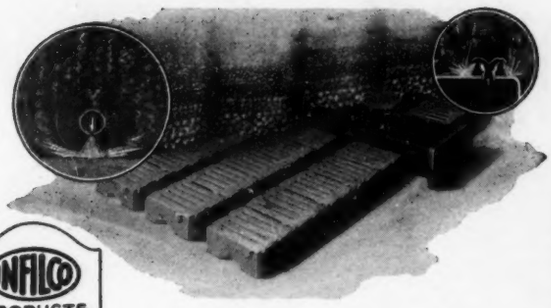

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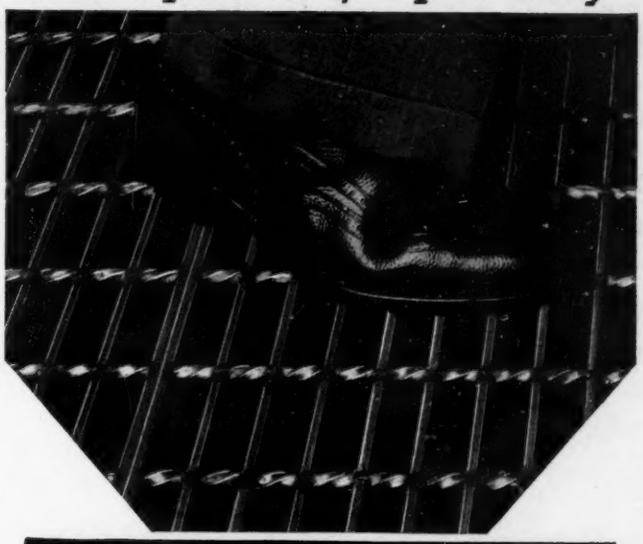

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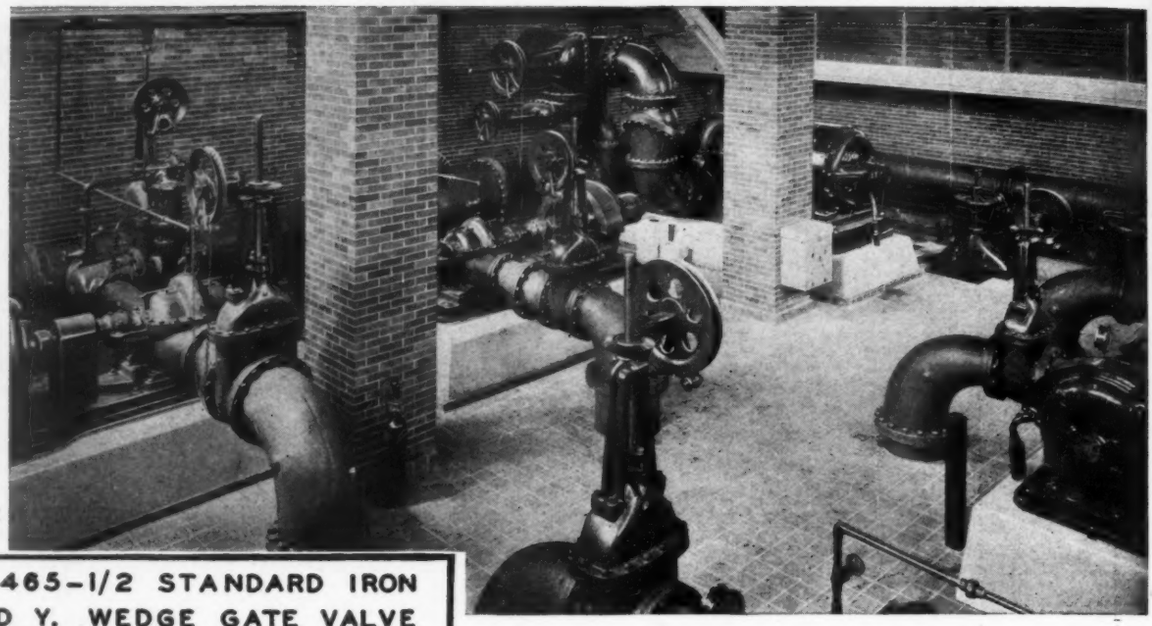

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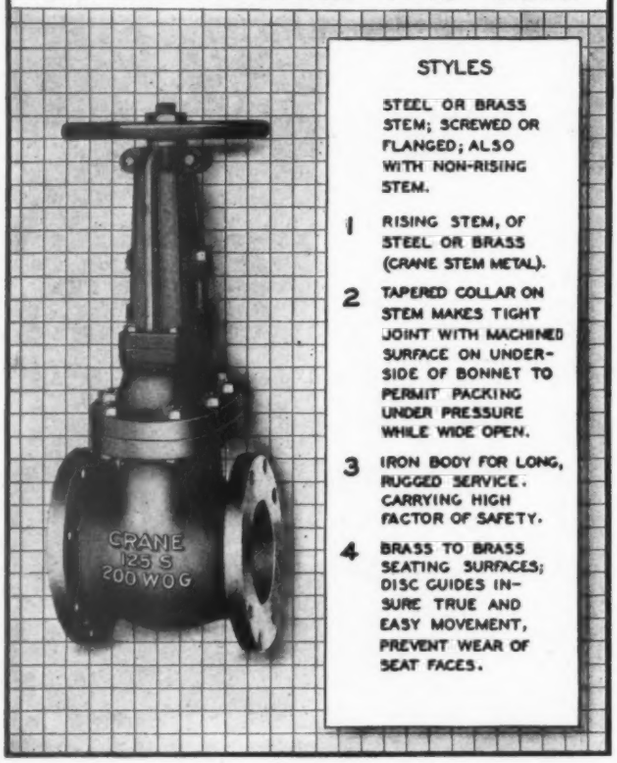

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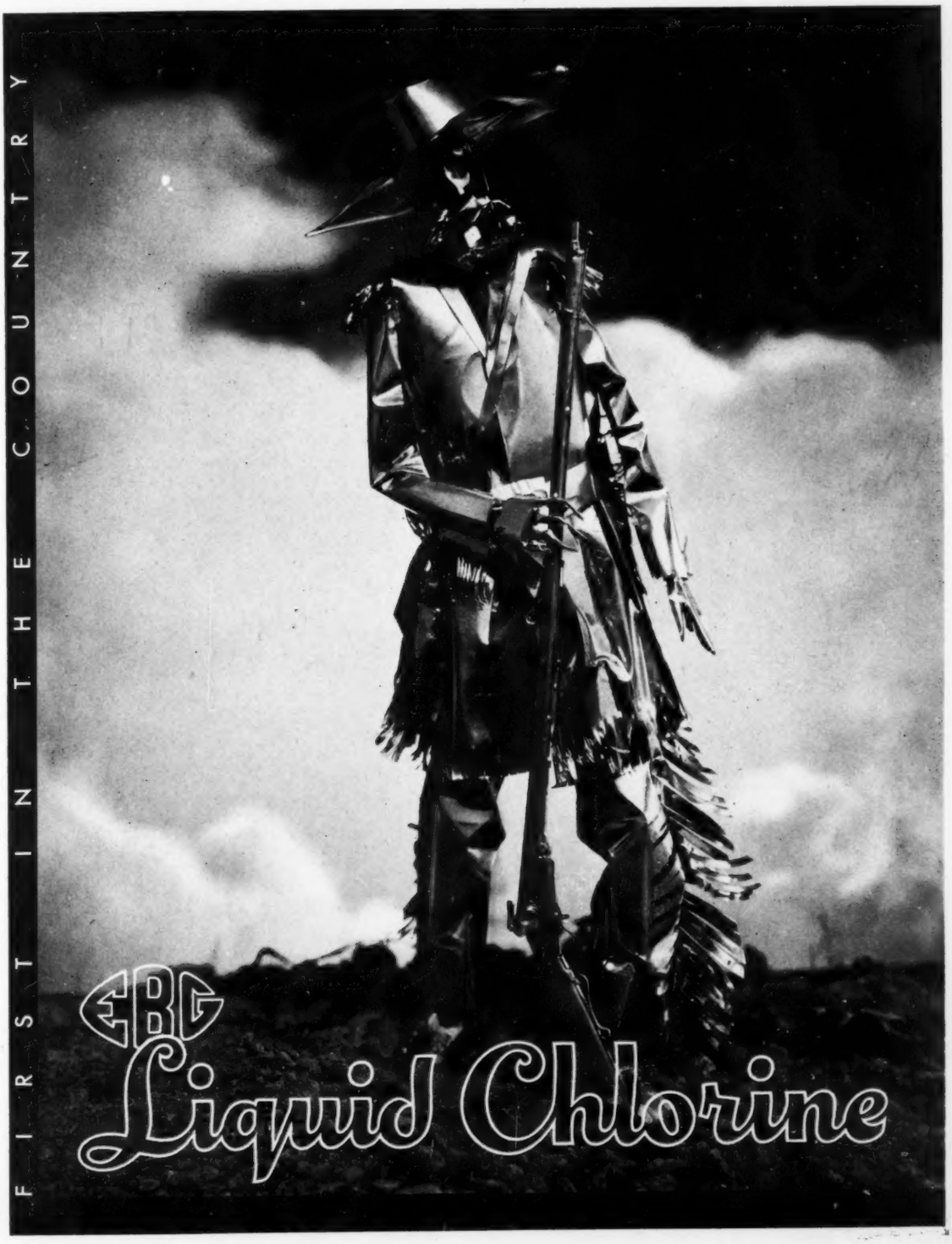

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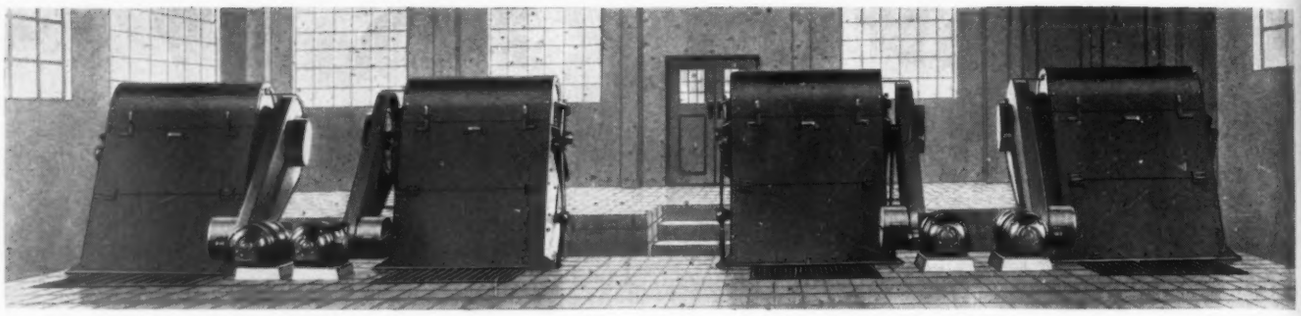
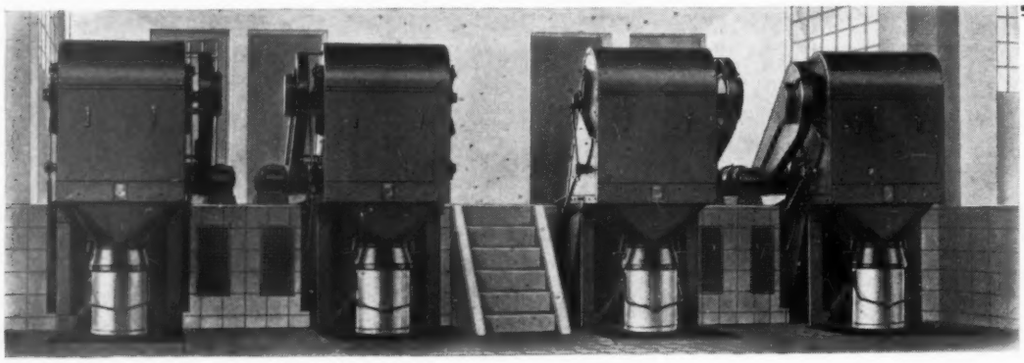


4 Rex Mechanically Cleaned Bar Screens—Metropolitan District Commission, Hartford, Connecticut. Note the neat appearance—the easy method of screenings disposal.



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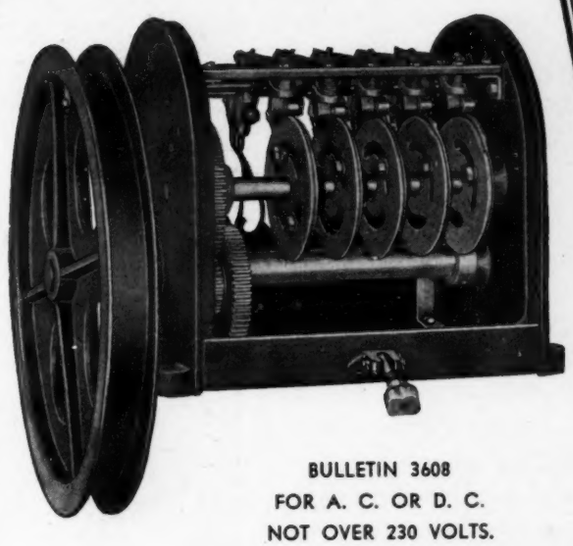

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Installation of cast iron effluent line for Long Branch N. J. sewage disposal plant.

CAST IRON PIPE

WATER WORKS AND SEWERAGE
A GILLETTE PUBLICATION
VOL. 83 JANUARY, 1936 No. 1

An Example of Plant Treatment: A Booster Station in the Residential Section of Augusta, Me.

PROGRESS IN WATER SUPPLY AND TREATMENT DURING 1935

By LEWIS V. CARPENTER, C.E.*

L. V. Carpenter

THE march of progress in water supply is onward, ever onward, but it moves in cycles. One year will bring forth a number of phenomenal new developments while other years will be utilized in adapting these new things to the operation of water supply and treatment plants. The past year has witnessed a cycle of improvement and adaptation. The present trend in treatment is (1) to more carefully prepare the water for treatment; (2) increased use of mechanical equipment for mixing, flocculation and the continuous removal of sludge; (3) study of the part that the upper sand layers play in filtration and methods of cleaning those layers; (4) further development in the use of filtering materials other than sand; (5) increased use of the ferric-iron salts in coagulation; (6) a more careful study of the causes of tastes and odors.

Municipalities that borrowed money for water works improvements, under the P.W.A. regulations with their 70-30 ratio, are loath to borrow more on the 55-45 ratio for fear of still more liberal terms being offered by the Government in the future and have confined their major improvements to those that can be built with funds secured through W.P.A., which requires a very small outlay on the part of the municipally owned system. There is a growing movement among municipalities to purchase water systems now operated by private companies. The number of municipally owned plants has increased materially during the past year. It is extremely difficult to even estimate the amount of money that has been expended for new construction because so much of the labor cost has been contributed from relief funds.

The year 1935 should definitely be labelled a year of water supply progress because the municipalities have been able to improve their plants with but a small capital outlay. With the privately owned plants, however, the conditions have been reversed. Income has been cut, and in many cases severely, and taxes have increased. Many municipalities have refused to pay fire hydrant rental and other charges for public water supply. In some instances the situation became serious. A private

Another Example of Trend Toward Plant Beautification. One of Several Small Pumping Stations at Eau Claire, Wis.

*Associate Professor of Sanitary Engineering, New York University.

1,000,000 *Gallon Radial Cone Bottom Tank,* 100 *Ft. Tower Built for City of Rocky Mount, N. C., in* 1935 *by Chicago Bridge & Iron Works*

water company in a Pennsylvania town in retaliation and out of desperation had the threads on the fire hydrants rendered non-serviceable when the town refused to pay the fire hydrant rental.

Elevated Storage and Beautification

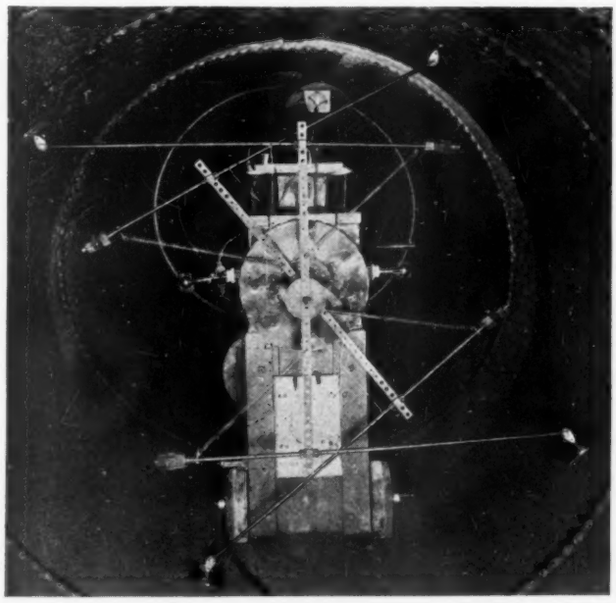
Architecture and landscaping are playing an important part in the development of the newer water plants and while we read of the architectural beauty of foreign water plants, a number of plants recently built in the United States and Canada far surpass any that have been built anywhere. New plants are being constructed better and old ones are being renovated so that citizens are proud of the plant and organization which produces their water supply. In the past few years improved facilities have been made available for providing more satisfactory and effective elevated storage. The development of elevated tanks of large capacity and relatively shallow depths and their improved appearance, has led many water utilities to improve pressures on the distribution systems and at the same time to lower the pumping demand charge and operating costs by providing elevated storage. Elevated storage has materially reduced pulsations at Detroit, and Milwaukee has improved pressures and lowered pumping costs with the installation of two 1.5 m.g. elevated tanks. Indianapolis, Kansas City, Kan., Burlington, Iowa, Dallas, Tex., and Spartanburg, S. C., improved distribution by the use of elevated storage. Waukesha, Wis., constructed a vertical standpipe with the shell of pre-stressed concrete built of vertical panels which gave an economical design as well as a pleasing appearance.

Pre-stressed concrete is rapidly becoming a favorite material in the waterworks field, for the manufacture of pipe and elevated tanks. Cast iron is still the predominating material for distribution systems and marked improvements have been made in its manufacture. For bell and spigot pipe, sulphur compound joints continue to make gains over calked lead on account of the cheapness and superior tightness. One manufacturer has introduced a new sulphur compound which forms a joint which is immediately water tight, and possesses more elasticity than the average compound. Transite pipe has been used on a large number of small jobs and engineers are inclined to accept the rubber gasket type of joint, on Transite pipe in addition to steel or cast-iron pipes. The manufacture of arc-welded steel pipes has reached a high state of efficiency by the aid of the automatic welding machines. Welded pipe has almost entirely superseded riveted pipe, being generally more efficient as to joints and having smooth interior and exterior surfaces which favor a high coefficient of carrying capacity and permit easy application of protective coatings and adaptation of flexible mechanical joints.

Spun linings of either cement or bituminous material are now being applied to steel and cast iron pipe. Exterior coatings of tar enamel or cement mortar are being applied by highly developed wrapping processes which apply the coating at the trench. Reinforcing mesh is being used to a certain extent to hold the exterior coating. Until recently the only criterion of a good coating job was its appearance and the eye of the inspector was not sharp enough to see the small pinholes with the result that often a poor coating job was buried. G. W. Clarvoe developed an electric flaw-detector based on the principle that the instantaneous dielectric strength of pipe enamel is greater than that of air. The enamel is subjected to a high voltage electric stress for a brief interval, the voltage being sufficient to break down very thin pockets of the coating which are not considered sufficient for the underground protection of the pipe. The source of high voltage in this detector is a spark coil or transformer delivering a secondary voltage of from 10,000 to 75,000 volts and is adjusted to give breakdowns on coating spots thinner than 1/32 inch. Such testing insures an effective and dependable coating.

Valuable Studies of Pipe Depreciation

The results of a two year study of pipe friction was published in September by the Committee on Friction



Reconditioning Interior of Old 72 inch Main with Cement Lining Applied by Machine.

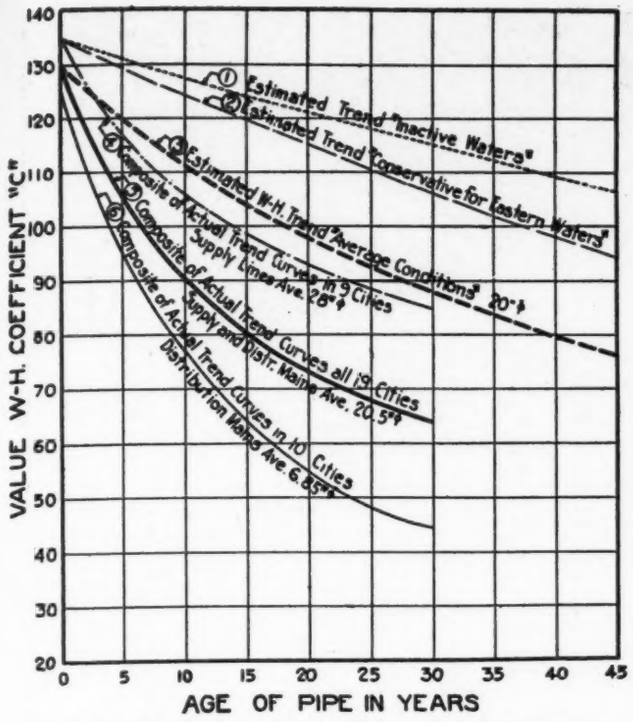

VALUE W-H. COEFFICIENT "C"
AGE OF PIPE IN YEARS
① Estimated Trend "Inactive Waters"
② Estimated Trend "Conservative for Eastern Waters"
③ Estimated W-H Trend "Average Conditions" 20%
④ Composite of Actual Trend Curves in 9 Cities Supply Lines Ave. 28%
⑤ Composite of Actual Trend Curves all 19 Cities
⑥ Composite of Actual Trend Curves in 10 Cities Supply and Distr. Mains Ave. 20.5%
Distribution Mains Ave. 6.85%

FIG. 1.— SUMMARY OF ESTIMATED AND ACTUAL TRENDS OF AGE-COEFFICIENT RELATION FOR TAR-COATED CAST-IRON PIPE.

Curves 1 *and* 2 are based on data for steel pipe (U. S. Dept. of Agriculture, Bull. 150, 1930).

Curve 3 is based on the Williams-Hazen Tables for average soft unfiltered river water.

Curve 4 is a composite for supply and transmission lines 16 in. or larger in diameter.

Curve 6 is a composite for distribution mains less than 16 in. in diameter.

Curve 5 is a composite of Curves 4 and 6. Composite curves are based on arithmetic averages.

Actual vs. Estimated Losses in Main Capacities with Age Increase. Summary Curves Taken from the Report of the Committee of N. E. W. W. A. on Pipe Line Coefficients.

Coefficients for Pipe Lines of the N.E.W.W.A.—E. T. Killam, Chairman.* Upon the basis of average data they found that in nineteen cities the average of "C" in the Williams-Hazen formula was 64, as compared with a value of 88 predicted from the tables. In eight out of ten systems the value of "C," for distribution mains, after 30 years of service was less than 50, involving a capacity loss of 61.6 to 84 per cent, as compared with a predicted loss of 37.5 per cent. The Committee concluded that the Williams-Hazen predicted trends are applicable primarily to large mains carrying relatively inactive waters and does not represent "average conditions" to be expected under modern methods of water treatments and water supply developments.

Cleaning of mains in place by means of a traveling scraper has been practiced for a good many years, but recently more interest is being shown in the practice. There has been a gradual improvement of the apparatus to remove the rust without injury to the lining. A 48-inch steel submerged line into Lake Erie was cleaned under a depth of 30 feet of water. It was necessary to introduce the machine beneath the water at a depth of 30 feet and the entire line cleaned was in this depth of water. A very ingenious scraper was designed that could be folded up and then opened inside the pipe line.

*See Journal of the New England Water Works Ass'n, September, 1935.—Ed.

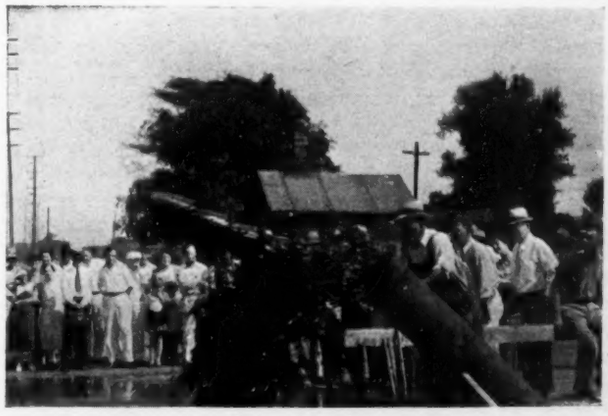
National Water Planning

In January of this year there appeared the report of the Water Planning Committee of the National Resources Board. The major portion of this report consisted of an inventory of the water resources of the United States. This constitutes the first attempt at a comprehensive inventory of the country's water resources and the report is replete with maps and diagrams showing the distribution of water in its various phases over the country.

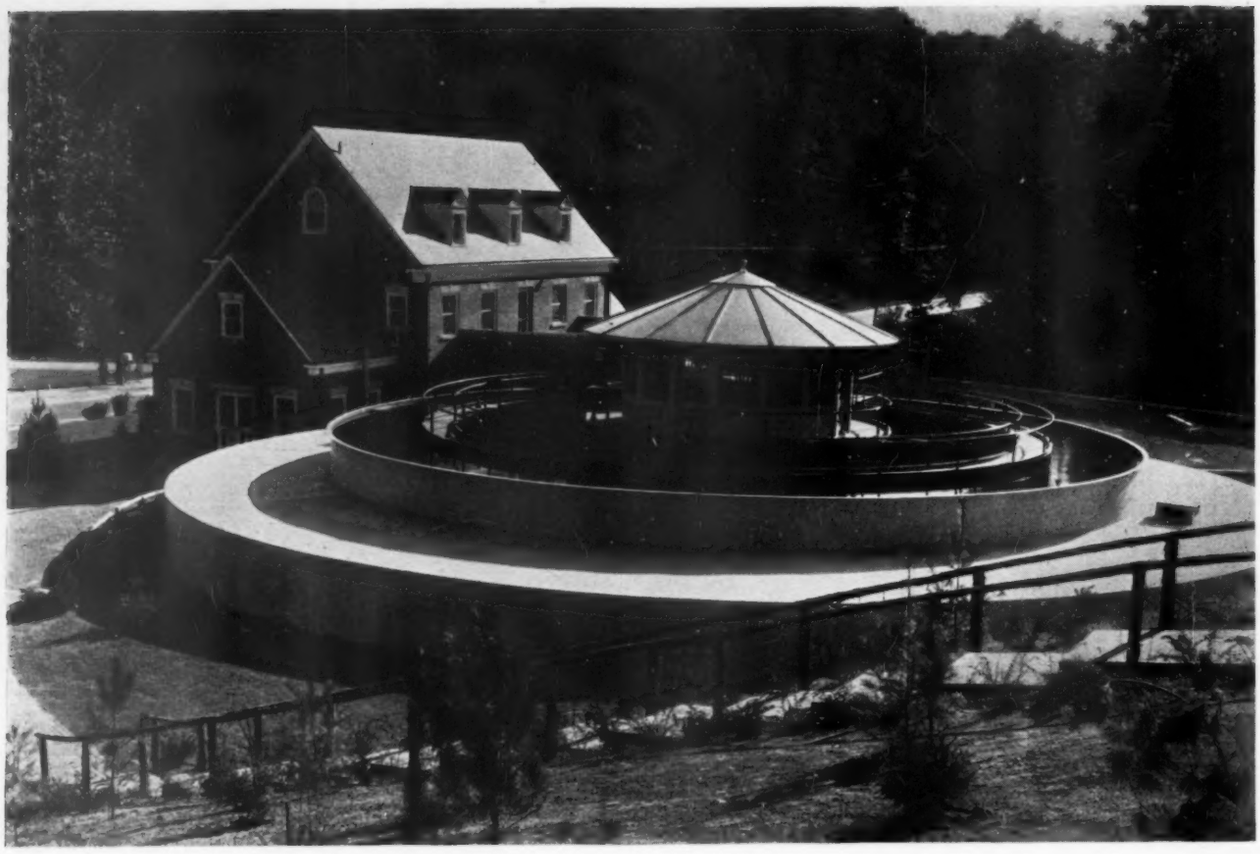
The tenure of the National Resources Board having expired at the end of the fiscal year June 30, 1935, the President by executive order created its successor, the National Resources Committee. This Committee appointed a subordinate committee on water resources known as the Water Resources Committee. The membership of this present Water Resources Committee consists of the representatives of seven Federal agencies dealing with water problems, and three members not connected with the Federal government. The latter are, Chairman, Abel Wolman, State Sanitary Engineer of Maryland; H. H. Barrows, Professor of Geography, Univ. of Chicago; and Thorndike Saville, Associate Dean of Engineering, New York University. This committee has succeeded to most of the duties of the former Water Planning Committee, the latter committee being retained as an advisory group. The Water Resources Committee has during the past six months initiated efforts looking toward coordination of the water resources activities of the several Federal bureaus, and has made special investigations and reports either through members of its staff of else through special Boards of Review, dealing with controversial water problems. Most of these have been in the arid and semi-arid states where problems are most acute.

Air-Conditioning and Consumption

The rapid decline in water consumption that started in 1930 reached the low point in 1933 and the water usage is increasing in all sections of the country. Increased activity along the industrial lines accounts for a large part of this increase, as has the growing use of air conditioning. Estimates have been made that a small residence, completely air conditioned [without a cooling tower], will use 40,000 gallons of water per month during the summer. With a cooling tower and recirculation the consumption may be reduced 75 to 90 percent. Some waterworks men feel that the continued development of air conditioning will render filtration plants and distribution systems inadequate. Others welcome the additional load with the subsequent revenue and are preparing to



An Increasing Interest Is Shown in Cleaning Water Mains. This Job Was at Evansville, Ind.



The Most Unique Filtration Plant in America Is Being Duplicated. The Burnt Mills Plant of the Washington Suburban Sanitary District.

handle the load. In towns where there is adequate ground water most of the larger buildings are drilling wells for cooling water supply, rather than use the municipal supply because the ground water is usually cooler. The quantity of water used depends upon the system of cooling used. Last summer one large New York Department store displayed a large sign in block letters, "We use 20,000,000 gallons of water daily to cool the air."

America's Most Unique Water Plant

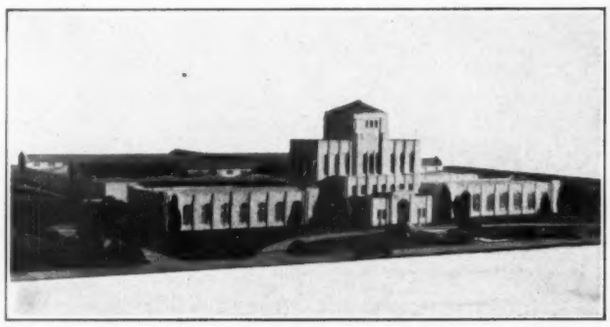
America's first rapid sand filtration plant built entirely of curves*, celebrated its first birthday and the operating results were in accordance with expectations of its designer—Robert Morse, Ch. Engr., Washington Suburban Sanitary District. The five million gallon circular steel plant, just 100 ft. in diameter, at Burnt Springs, Md., was an innovation and had several features which were new in design. The open filters and coagulation basins were given a thorough test during the past winter when an average minimum temperature of 19.7 degrees was reached for 90 consecutive days. Operation results showed that during the severe winter the open filters although covered with 11 inches of ice at times, consistently produced an excellent effluent without damage to the filters. A new 5,000,000 gallon plant, an exact duplicate of the first one, is now under construction. This plant has provided American engineers with a new and unique design, and should encourage departures from the conventional and the development of new and improved structures for water works systems in general.

*The author of this review has dubbed the Burnt Mills plant—"The Mae West"—all curves, no bulges or corners.—Editor.

Engineers are making greater use of structural steel fabrication in the design of plants. Circular steel tanks have a wide application and many of the newer plants are using mechanical mixing in circular steel tanks and two of our large private water companies have adopted circular steel coagulation basins as standard. One of the latest designs introduces the raw water with the coagulants at the circumference of the tank and by the use of spiral baffling the water is delivered at a constantly diminishing velocity to the center of the tank. The efficiency of this type of basin is very high and the structure is exceedingly cheap and easily installed, as compared to the conventional concrete basin.

America's Largest 1935 Plant

The outstanding new plant being constructed during the year is the 200,000,000 gallon plant for the City of Milwaukee, recently described in this magazine by L. R. Howson, Designing Engr. The entire plant is being



Model of Milwaukee's 200 M.G.D. Filtration Plant, Now Under Construction.

built upon made ground from the shore outward into the lake. A revtement wall of impervious type was constructed enclosing the 30 acre lake area in which the plant is being built. This wall is thirty feet thick and the fill has proved so impervious that the only pumping necessary to keep the thirty acre tract dry has been that occasioned by the rainfall on the area itself. The plant will have two-story settling basins into which the water enters at the bottom, flows across, then upward to return through the upper section. The first 76 feet of each 372 ft. length of flocculating chamber is utilized as a coagulating and floc preparation chamber in which are installed Duplex Flocculator units.

The filter plant itself consists essentially of four 50 m.g.d. plants of eight 6¼ m.g.d. units at a filtration rating of 2 gallons per sq. ft. per minute. The underdrains are of the conventional cast iron manifold and laterals with 7/16 inch orifices at 6 inch centers. Provisions are made for a 36 inch vertical rise and the Baylis method of surface wash involving an upper pipe grid. The surface wash water will be discharged through 2 inch laterals with ¼ inch perforations on 8 inch centers, with bottoms located 2 inches above the normal sand level. The filter gravel is 24 inches thick and the sand bed (effective size between 0.45 mm. and 0.5 mm.) is 22 inches deep.

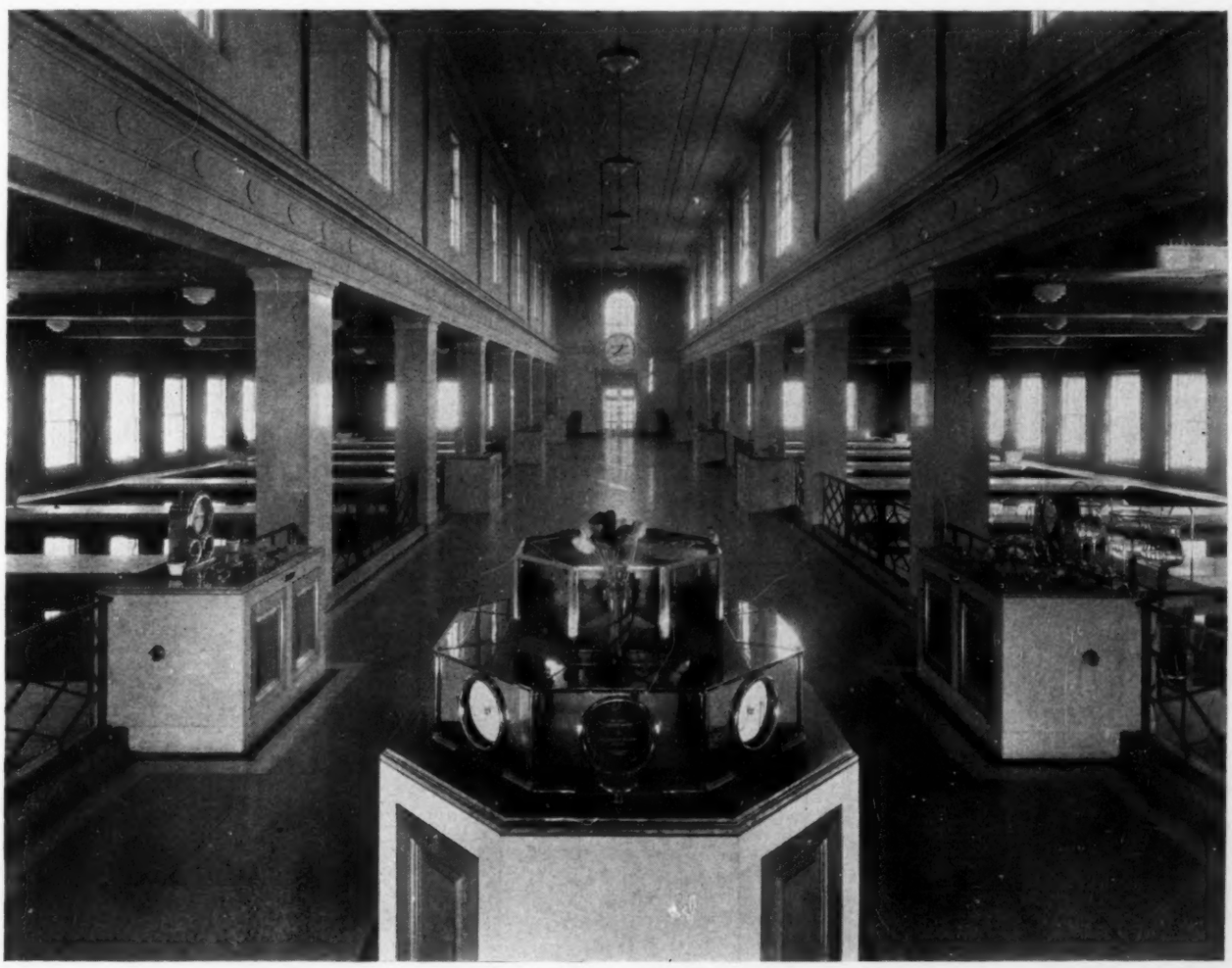
Facilities are provided for the feeding of alum, lime, ammonium sulphate, activated carbon, liquid chlorine and ammonia. The bulk chemicals will be delivered to the plant in trucks and will be elevated by a pneumatic conveyor system to elevated storage bins having a capacity of 70 tons each. The movement from these bins will be by gravity. An elevator is provided for handling bagged chemicals also. The filter building 297 feet x 390 feet in plan is given a "garden wall" type of exterior treatment. There are no windows, light being provided from large skylights, one over each filter vent, and from windows in the upper walls of the operating galleries.

Anthracite as Filter Media

"Anthrafilt" apparently has found a place as a filtering media for rapid sand filter plants. During the year "Anthrafilt" has been used for the first time in 14 or more plants, amongst these being Little Falls, N. J.; Chester, Pa.; Southern Pines, N. C.; Wilkinsburg, Pa.; Bethel, Conn.; Phila. Suburban Water Co.; Raton, N. M., and others.

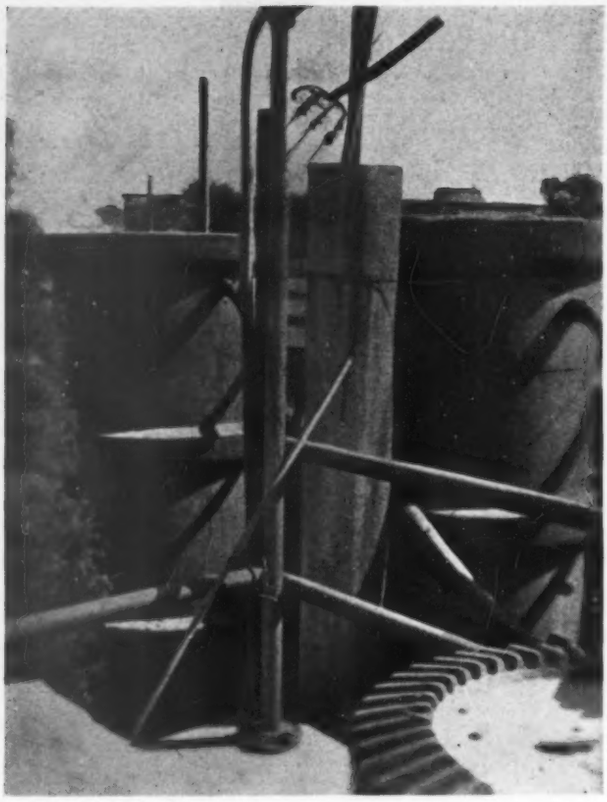
Raton, N. M., built a filter unit containing 10 inches of graded gravel followed by 18 inches of activated carbon of 6-14 mesh. A 14 inch bed of anthrafilt, having a uniformity coefficient of 1.6 and an effective size of 0.6 mm. was placed directly on the carbon bed without the use of screens. After the filter was washed, a core of the bed showed both the anthrafilt and carbon graded from coarse to fine, but there was a distinct separation between the two materials. The carbon-anthrafilt unit is reported to have delivered nearly twice as much water as the sand filter of the same size, used much less wash water, and delivered a better effiuent.

Ripple, at Denver, has placed filters in service in which six inches of anthracite coal, effective size 0.8



The Eye Appealing Filter Operating Floor at Lancaster's (Pa.) Plant.

Water Works and Sewerage—January, 1936



Ferrous Chloride Towers at Oklahoma City Softening Plant. Terra-Cotta pipes filled with scrap-iron.

mm. is placed on top of 14 inches of 52 mm. sand. This combination filter gave better performance than sand alone, with reference to length of run, rate of filtration and percentage of wash water. The coarse anthracite on top of the sand acts as a roughing filter and the sand did not clog up as rapidly. R. W. Haywood at Easton, Pa., has reached the same conclusions in recent experimental applications of "anthrafilt" or sand filters.

Filter Washing

The high velocity wash which took the water works men by storm within the past few years is losing its glamour. Bouson, at South Pittsburgh, has found that regulating coagulation so as to keep a minimum of residual alumina (1 p.p.m. as Al_2O_3) in the applied water stops the formation of mud balls. The writer presented his findings, that waters which coagulated most economically at pH 6.9 showed the highest removal of alumina when the pH value was dropped to 6.2. Efficient coagulation and a more readily washed filter media appears to eliminate the major filter bed troubles which have caused advocacy of extremely high velocity washes. Several plants which have adopted high velocity wash have examined the filters and found that while the surface remained apparently clean the higher gravity mud balls had penetrated the bed, in some cases, into the gravel. Baylis has found that most of the filter bed troubles originate at the junction of the gravel and sand. He is a strong advocate of the surface wash and a number of old plants, and also the new Milwaukee plant, are being equipped with special wash water systems to direct a high velocity stream of water in the upper six inches of the sand bed. Surface wash appears to have merit and certainly would be very valuable to those plants which would otherwise have to be constructed to use high velocity wash. Air wash is coming back again into prominence, and the writer, amongst others, thinks that the air wash, followed by not more than a 24 inch vertical rise (with proper attention to coagulation), will keep a filter bed in excellent condition.

Chlorinated Iron the Newest Coagulant

More plants are making use of the iron salts in the treatment of water. Richmond, Va., adopted chlorinated ferrous sulfate (chlorinated copperas) and bulk handling of chemicals that saves over $10,000 per year in coagulation costs. Mechanically, the most important improvements at the Richmond filter plant have been the installation of a pneumatic unloading and reclaiming system for heavy solid chemicals, and the installation of two chlorinators, each having a capacity of 1,000 pounds per day and with them a transfer panel by means of which the chlorine solution of any one of four chlorinators may be applied at any one of three places. The plant scale work with chlorinated ferrous sulfate as a coagulant has been most successful, and it has proved to be the most effective coagulant that has been used at Richmond, both as to water quality and economy.

Oklahoma City constructed a home-made ferrous chloride (not ferric) plant utilizing scrap iron and chlorine for use in their water softening coagulation. This ferrous chloride process effects a saving of about 15 per cent over the alum treatment and produces improved coagulation.

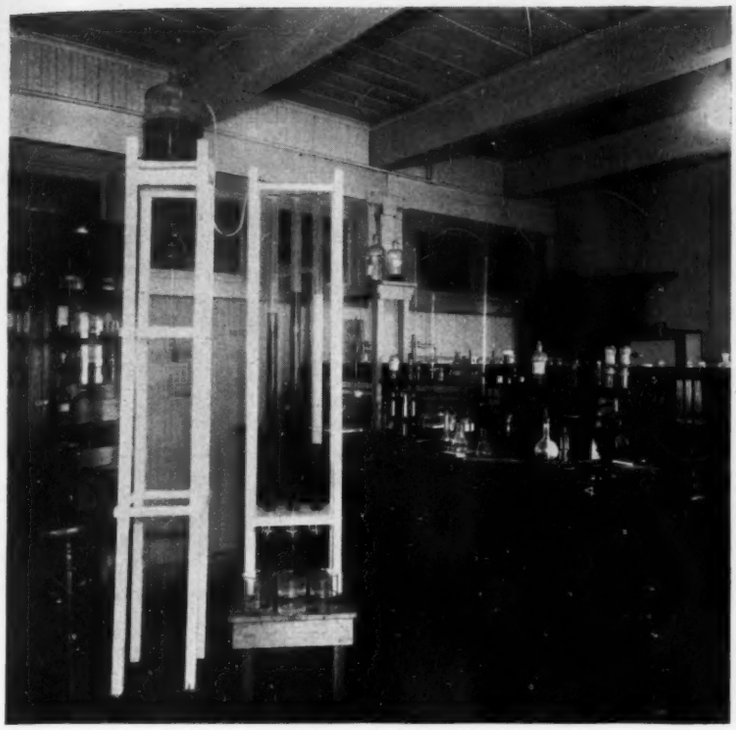
Ferric chloride coagulation is popular in some parts of the country, particularly the Pacific Coast. At the Wilmington plant of the Department of Water and Power at Los Angeles, the use of ferrous chloride continues to produce remarkable results in the reduction of color. The manufacturers have developed solution feeders for ferric chloride and the chemical in various forms can be purchased at a more reasonable rate than heretofore. Anhydrous ferric chloride (100% $Fe Cl_3$) has been introduced on the market during the year.

"Black Alum," a filter alum impregnated with activated carbon, has been introduced as a substitute for alum. Over 2,000 tons of this material has been used in experimental work and results indicate that the carbon in it will stabilize the sludge in the coagulation basin and keep the sand in a sweet condition. The floc produced is easier to see and control.

Taste and Odor Control

Baylis' new book, "Elimination of Taste and Odor in Water" was published early during the year and it gives a fine summary of work that has been done. Over

Diesel Power Is Being Used in the Water Works Field. The Above Unit Which Drives 6.5 M.G.D. Pump at Nashua, N. H., Was Recently Installed.



Laboratory for Instruction in Sanitary Engineering at University of West Virginia. [Former Hideout of the Author.—Ed.]

one-half of the book has been given over to carbon and Baylis makes the statement that all tastes and odors usually found in water can be removed by carbon, if the product is right and enough is added. Carbon apparently has come to stay and there are more than a thousand filter plants that are using it periodically. It has been found that it can be added at practically any point in the process and improve the quality of the water. Most of the new work during the year has centered on the use of activated carbon for the stabilization of sludge in coagulating basins and the use of it in wash water for improving the condition of the filter.

Ammonia is still being used with success in many cities. The most recent and economical practice in final sterilization is the addition of chlorine first and ammonia later, the ammonia being used in amounts only to combine with existing residual chlorine leaving the filtered water reservoir. London, England, still continues to use ammonia, with satisfactory results, and the largest ammonia-chlorine plant yet built has been placed in operation at Chicago. The value of the ammonia-chlorine treatment to prevent biological growths and tuberculation in mains was proved again at Utica, N. Y., where tuberculation of the long supply lines has continued to be checked by the ammonia-chlorine treatment at the reservoir. Ammonia-chlorine is being increasingly used to stop dead end corrosion (red or black water) and consumer complaints of bad tastes or odors.

Los Angeles developed a method of coppering reservoirs by broadcasting pulverized copper sulfate over the reservoir surface.

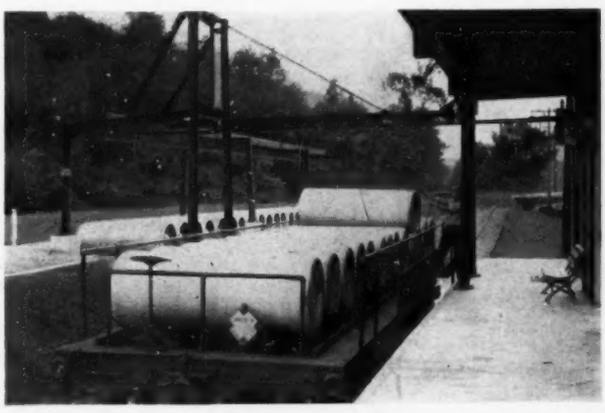
Corrosion Control

More plants have adopted corrosion control by adding an alkali subsequent to filtration. Some plants are adding caustic-soda (NaOH) rather than the hardness producing $Ca(OH)_2$-lime. In relatively soft waters it has been found necessary to raise the pH to as much as 9 or 10. As the calcium bicarbonate hardness increases the pH value becomes less.

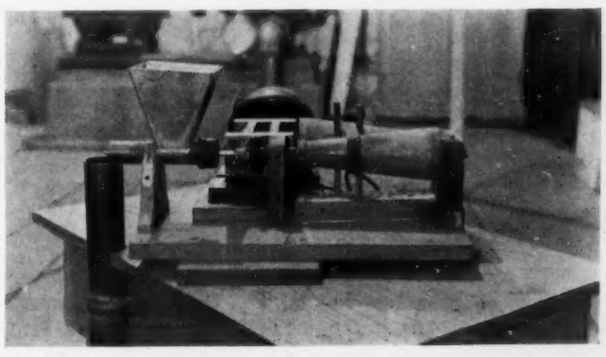
Inhibitors are still being used with acids for cleaning plumbing systems in large buildings. Zeolite plants are being constructed which remove iron and manganese satisfactorily, and there is a distinct trend towards installation of zeolite softening plants instead of lime-soda plants in the smaller towns.

Gadgets and Kinks

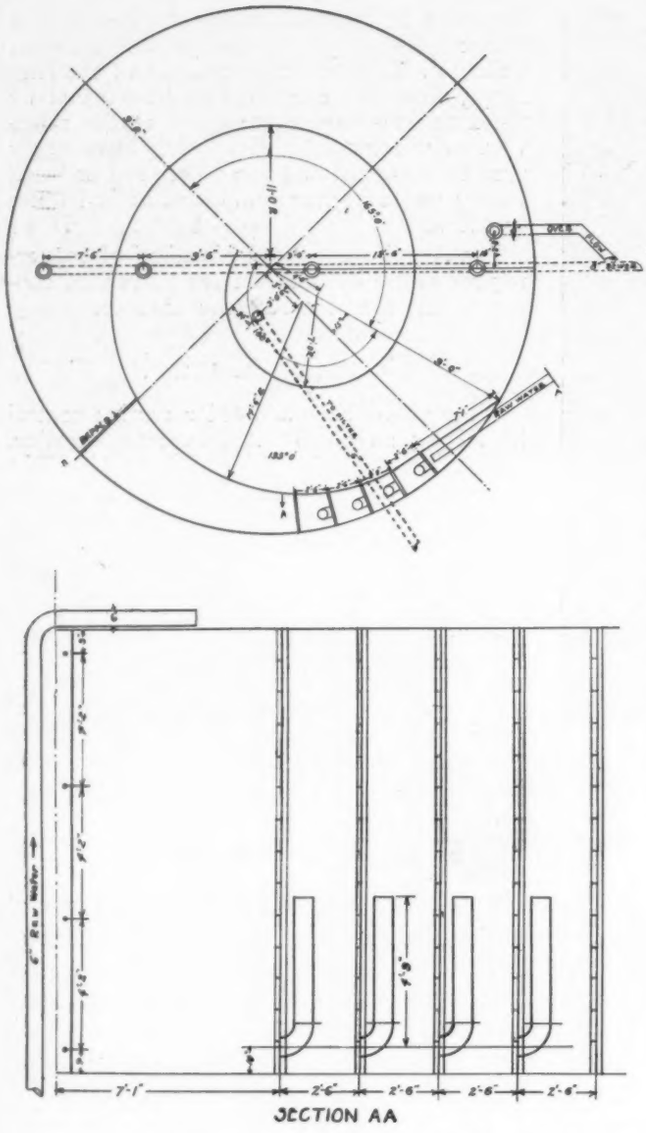
Kinks and gadgets have come in for their share of publicity during the past year. Several of the water conferences throughout the country have offered prizes for gadgets and these exhibits have stimulated water works men to bring their "tricks of the trade" before the public. Some outstanding kinks and gadgets include: Use of ice-cream salt and compressed air for cleaning services; a dry feed machine mounted on wheels for experimental purposes; device for applying surface wash to filters using a hose and suspended pipe with orifices; home-made chlorinators for wells; a variety of laboratory devices for counting bacteria, titrating, holding petri dishes, etc.; nails spaced at definite intervals on the sides of filters for calibrating rate controllers and measuring wash water rates; dry ice used for recarbonation; pumping back part of flocculated material to the mixing chamber to aid coagulation; sand expansion apparatus, etc.



Chlorine Handling at Richmond, Va., for Making Chlorinated Copperas.



A "Gadget." A Home-made Dry Feed Machine Constructed by H. W. Speiden at Morgantown, W. Va.



Circular Steel, Spiral Baffled Mixing Chamber and Coagulating Tank, in Plan and Cross Section.

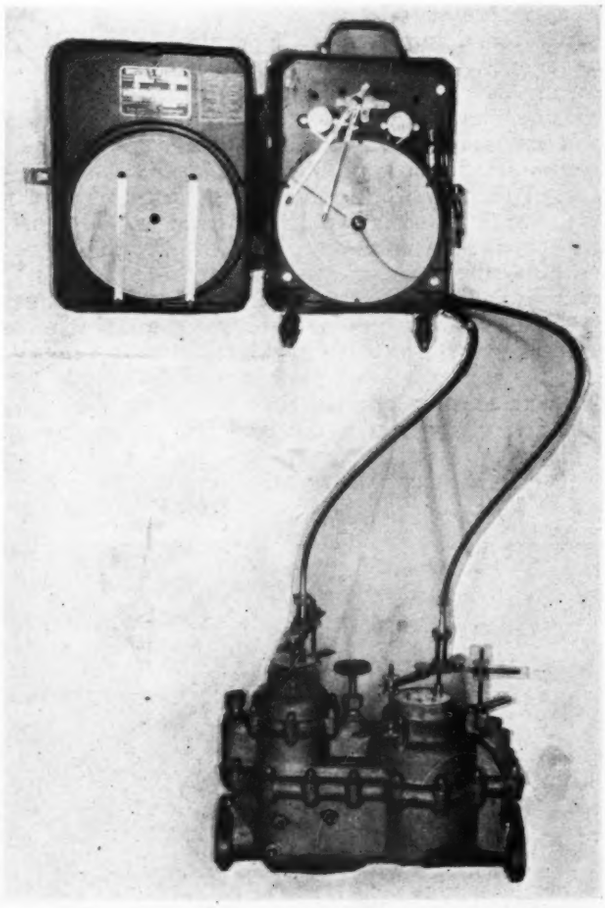
Operator Licensing

The Committee on Licensing of the A.W.W.A. issued their report which has created considerable discussion. Texas, California, Georgia are operating voluntary licensing systems. This is one means of educating the operator to appreciate the value to him of registration laws. The Ohio Water Conferences went on record as favoring legislation in Ohio to take the place of their present system where they have to register as engineers. Some of the chemists of the larger plants are opposed to registration on the grounds that it lowers their professional status. [On this point the reader is referred to the article by E. S. Hopkins in Water Works and Sewerage for December 1935 and the Editorial in the same issue.]

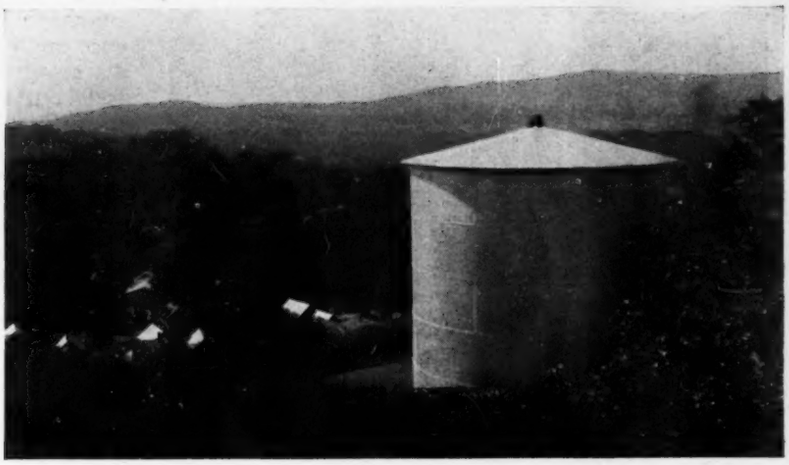
Licensing or registration of some form will offer to the water works operator a certain immunity from political interference and will not only tend to improve working conditions but operation of the plant as well.

The Annual Convention of the A.W.W.A. at Cincinnati had the largest attendance in recent years and water-works meetings throughout the country have been better attended and shown increased interest in new developments. Short schools have thrived and many new ones are being held. The N.E.W.W.A. sponsored one school in New Hampshire, and Virginia holds a series of ten schools throughout the state so operators can attend without being away from home at night. The Pennsylvania Water Works Association is holding district schools. West Virginia, Georgia, Indiana, Illinois, Florida and several other states are holding schools as well as state conferences. Conferences and schools have been held in the following states during the year: Alabama, Arkansas, California, Colorado, Florida, Georgia, Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Montana, New York, North Carolina, North Dakota, Ohio, Oklahoma, Pennsylvania, Tennessee, Texas, Virginia, West Virginia, Wisconsin. This leaves 23 states that are apparently not doing anything to improve the operating personnel of water works plants.

As the old year passes on and a new one is upon us, there are many signs of encouragement for waterworks men in the new year. Consumption of water is on the increase, with a subsequent increase in revenue; industrial conditions are improving, making collections easier; and more is known about operation, which makes for less worries at the plant. The new year should see a renewed interest in the professional societies, and various short schools, conferences and conventions, with a result that the end of the year will find a better educated waterworks personnel and a growing respect for the profession.



Amongst New Equipment the "Meter Master" Is Outstanding. It Is Used for Many Purposes—Settling Disputed Bills on the Customer's Property Being One Important Use.



250,000 *Gal. Standpipe on New Water Works System —Hinsdale, N. H.*

DECEMBER MEETING OF N. E. W. W. A. WELL ATTENDED

GOOD weather and an interesting program brought to Boston close to 200 men, from Maine to New York, to attend one of the series of monthly meetings of the New England Water Works Association held on December 20th at Hotel Statler.

The forenoon session was given over to a highly interesting "Round Table," under the leadership of Donald Calderwood of the Nashua (N. H.) Water Co., which was so ably conducted as to bring forth especial commendation and congratulations from the association's live wire president, Roger W. Esty of Danvers, Mass., at the luncheon session. A digest of the "Round Table" discussion will follow.

Remarks of the President

Mr. Esty remarked that it was difficult for himself, and many of those who had gotten so much of benefit from the association and its meetings, to understand the reason for recently published statistics revealing the low percentage of American water works systems which were represented in the American Water Works Association. With a great deal of satisfaction he could vouch for the value of the New England Association, the meetings of which he could not afford to miss. In fact, he could recall but one that he had missed in 15 years.

Mr. Esty announced that the meeting scheduled for January 16th in Boston was to have a "Round Table" led by Sidney S. Anthony, Sup't of Water Works, Augusta, Me. Other meetings scheduled—Hartford, Conn., April 21st; Concord, N. H., May 21st; and the Annual Convention (dates not yet set) would more than likely be held in New York City if present plans materialized.

Roger W. Esty, President; Supt. Danvers, Mass., Water Dept.

Don C. Calderwood, Engr., Nashua (N. H.) Water Co.

Technical Papers

The afternoon session was opened with an illustrated lecture, by Professor Melville C. Whipple of Harvard University, which was an answer to the question "What are Algae and what do they look like?" Professor Whipple's lantern slides answered the last most effectively. In his talk he described the life habits, characteristics and ill effects from the many forms of algae and protozoa shown, particularly the common forms and those giving rise to difficulties in water works operation.

Called on to answer the question "Were algae ever deleterious to human health?" Mr. Kingsbury of the State Department of Health said there was no evidence that algae impregnated waters had caused disease, but there was the indirect danger that the foul taste or odor would drive consumers to private water sources, potentially dangerous if not actually so. With copper sulphate treatment effectively and systematically applied, he said there was little excuse for the appearance of serious taste troubles. However, as time went on he thought more filter plants would be built to remove undesirable elements from the New England waters, regardless of the public health aspect of the matter.

Asked if there was any practical means of *preventing* algae development at the source, Professor Whipple said that draining of feeder swamp areas and cleaning marginal areas of reservoirs was helpful. Others said that nipping the "bloom in the bud" by frequent copper sulphate application appeared to be the most practical solution. In some cases monthly applications had been made in lieu of the more exact method of routinely watching conditions with a microscope and coppering when organism numbers began to increase. Partial relief had come from taking water from a depth below which algae were less likely to be found but was not always the solution because decomposition products were prevalent below a certain depth. Further, such species as the diatoms would be found present to relatively great depths.

Arthur L. Shaw, Metcalf & Eddy Engrs., Boston, Mass.; Prof. M. C. Whipple, Harvard University, Cambridge, Mass.; Nelson Boardman, Asst. Supt. Water, Danvers, Mass. (With apologies of the camera-man working at sundown.)

A Study of Frost Penetration

Harry U. Fuller, Chief Engineer of the Portland, Me., Water District, presented interesting and enlightening facts pertaining to ground freezing and rates of frost penetration. He reported on certain studies being conducted in Portland in an attempt to make use of Weather Bureau daily temperature records to predict with some certainty the approach of trouble from frost penetration to the extent of a freeze up of services and later of mains. Evolving some sort of formula, making use of temperature records previously reported, was the objective.

A factor, in any formula devised to reveal penetration depth, he pointed out, would be the quality and moisture content of the soil, also the type of covering such as paving, grass, ice or snow. As the earth froze the *rate* of penetration increased, because of the poor insulating value of frozen earth. For example, when the ground was frozen 4 ft. down the next foot of penetration proceeded at a disastrously rapid rate. Mr. Fuller described the Portland test pits with one set of pipes buried under clay and another under gravel at increasing depths (from 6 in. to 5½ ft. cover), each having inserted a separate and accurate thermometer. Observations daily, if not more frequently, were to be correlated with air temperature records in the attempted calculated predictions, based on mass data of years of Weather Bureau records of mean daily temperatures covering a period of years. It, thereby, seemed possible to arrive at an accumulated temperature deficiency value by applying the formula and such deficiency dropped or increased from day to day or week to week as indicated by peaks and valleys on the graph. In the deep freeze reached in March 1918 the *accumulated* temperature deficiency (by formula) had reached 1500 F. degrees; in the deep freeze 15 years later (February 1934) it had been 1150 F. degrees. Apparently the frost penetration had been 5 feet or better at the 1150 degree deficiency in the more easily penetrated soils. The studies, now being continued and checked by use of the observation pit, might reveal a method of foretelling frost troubles and eliminate the embarrassment of being caught without effective preparation to meet them promptly.

In reply to questions, Mr. Fuller said that the supposition that snow removal from streets had been responsible for greater freezing troubles had not been borne out by facts. He also said that a deep freeze once in 12 to 15 years was not sufficiently distressing nor costly to justify lowering of mains deeper than 5 feet.

L. H. Enslow remarked that, aside from the preparedness element, a formula which would predict trouble from freeze-ups could be put to other profitable use. For example, last winter at least one Water Department had found a $10,000 unexpected revenue increase because every very cold snap had resulted in overnight faucet running by consumers wishing to avoid the inconvenience and cost of thawing out service lines. If consumers could be accurately warned when the danger point had been reached there would automatically result less thawing, more revenue to the water utility, and less expense and worry to the consumer. A newspaper notice warning those consumers experiencing freeze-ups in 1934 to allow faucets to run during the night would constitute a humane act of benefit to all—save possibly the plumbers.

PERCY A. SHAW, Supt., Water Department, Manchester, N. H., said that their records of 10-day moving averages of temperature last winter had indicated a more severe situation than the 1934 curve showed. Failure of services to freeze he could only attribute to the heavy snow blanket.

"The New Water Works System of Hinsdale, N. H., was described by ARTHUR L. SHAW, Metcalf and Eddy, engrs., Boston, who utilized lantern slides to pictureize his talk.

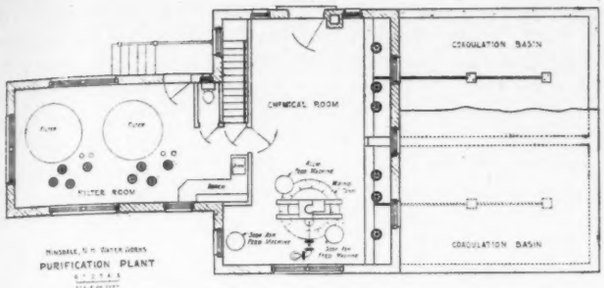
Hinsdale, with only 1500 residents, now had a modern filtration plant, standpipe and distribution system which, with two dams, had cost this small municipality $126,000. The filter plant had been put in to remove the color (100 ppm.) and correct the corrosiveness (pH 5) of the supply. It consisted of an economical combination of two wooden baffled concrete coagulating basins in parallel, a round welded steel mixing tank and two round welded steel gravity filters—all three units being 7 ft. in diameter and Bitumastic coated for protection.

The raw water entered the mixing tank through a baffled spiral chute inside the tank and thence flowed through the slow mixing (paddle-equipped) tank. Two W. & T. dry feeders applied alum (1½ gr./gal.) and soda ash (1 gr./gal.) to produce the floc. A third machine applied more soda ash (0.6 gr./gal.) to the filtered water to raise the pH from 5 to 7.8, or thereabouts for corrosion control. The filter beds were of conventional design, as was the perforated underdrain system. Rate controllers and indicating rate of flow and less of head gages had been provided as had a laboratory bench and testing equipment.

The all welded covered wash water tank (10,000 gal.) and the 250,000 gal. stand pipe were as attractive as they were utilitarian. In order to reduce the pressure on the system (gravity flow from filters) and to prevent stand-pipe overflow, a regulating altitude-valve had been installed on the main from the filter plant. Mr. Shaw pointed out the absence of a clear-water well at the filter plant had been permissible because of the ample stand-pipe capacity and the bypass around the filter plant. This plant was exemplary of what a small community could do when desirous of an ample and clean water supply. In operation but three

Harry U. Fuller, Chief Engineer, Portland (Me.) Water Distr.

Harold L. Brigham, Supt., Marlborough, Mass., Water Dept.



Sketch Plan of Hinsdale, N. H., Filtrations Plant. Circular Welded Steel Filters and Mixing Tank. Note Spiral Rapid-Mix Down Duct at Periphery.

weeks, the new system had demonstrated its value in controlling a serious paper mill fire. The distribution system had cost $74,500; the two dams, filter plant and supply main $51,600—the complete system, $126,000, or $84 per capita.

Superintendents' Round Table

(Leader—D. C. Calderwood, Nashua, New Hampshire)

The forenoon was devoted to the "Superintendents' Round Table" under the leadership of Mr. Calderwood whom President Esty paid high compliment. The first topic opened up for discussion was:

"Experiences With Diesel Engines and Pumping Station Maintenance"—DONALD W. FOSTER, Supt., Water Works, Wilmington, Mass., in outlining his experiences with Diesel equipment said that it had proved entirely satisfactory at Wilmington and that water could be pumped less expensively than had been the case with electric power. The simplicity of speed variation rendered Diesel pumping highly flexible. For fuel oil their average cost had been $3.90 per m.g., delivered against a 240 ft. head. They had estimated a depreciation of 4 per cent as ample, and overall pumping costs had been $30.70 per m.g. The engines had been quiet without mufflers, the exhaust being through 70 ft. of 6 in. C.I. pipe.

In reply to a question, Mr. Foster told of his experiences which had proven the value of adding to every 300 gls. of fuel oil 1 gal. of upper cylinder lubricant. Fuel oil and lubrication economy had resulted to some extent, but more important was the elimination of carbon from the exhaust and less fouling of the fuel oil spray nozzles. Mr. Foster considered the benefits noted had more than justified the expense of upper cylinder lubricant.

Mr. Calderwood reported that the new Diesel engine at Nashua, installed as auxiliary equipment, had operated only 70 days during the past summer, but the fuel cost per m.g. pumped had been only 33 per cent that of coal used in the old steam plant. Because of the power company demand charge of $200 per month on 250 H.P. motors, Diesel engines had been selected for the auxiliary and emergency station as the less expensive and equally if not more dependable source of power. In reply to a question he said that a careful engineering study had been made by the water company and Metcalf and Eddy Engineers before the decision was made. To insure dependability and preclude interrupted service, duplicate fuel-oil strainers had been provided in the installation.

"Maintenance of Distribution Systems"—JOHN A. READ, Asst. Supt., Water Dept., Manchester, N. H., in discussing this topic stressed the value of records. At Manchester they kept a large wall map of the system up-to-date. This was supplemented by larger scale section maps. In each car and truck the books of blueprints (12 x 9) carried had proved highly valuable in emergencies. For use in gate-valve testing and maintenance they had found the motor driven Toledo Power Head of great help in operating the valves. A portable Homelite engine-generator set (1.5 K.W.) supplied current to operate the power-head. Fire hydrants were inspected frequently for water in the barrel during winter and alcohol added to those found to be wet. The chief troubles with cement lined services had been corrosion of the couplings. For pipe and service thawing they had employed both steam and electricity.

Mr. Read said that he had found utility managers could learn much from the inspection tests applied by the fire underwriters and recommended calling for tests more frequently than normally would be the case. He believed that the importance of pipe cleaning had been under estimated—especially on pumping mains where even slight from friction resulted in considerable increase in pumping costs over a period of a year.

Mr. Read reported that they had recently purchased one of the new Brainard and Hatch "Meter-Masters" which had proven its value in several directions. Connected to the meter of a complaining consumer, the chart produced over a 24-hour period became a convincing record with which the consumer had been so impressed as to concede the correctness of meter registration and bills. In determining the accuracy of large meters and the size of service and meter most suitable, the recording Meter-Master had been highly valuable. As a result, several unnecessarily large meters had been replaced by smaller units now more accurately measuring consumption. In reply to a question Mr. Read said that the Meter-Master, which had cost $190.00, had already paid for itself several times over.

S. H. MACKENZIE, Supt., Water Dept., Southington, Conn., said that he could also highly endorse the Meter-Master, which they had used to good advantage in meter testing and settling complaints. In testing hydrants for water in the barrels they used a rubber hose and a piston hand operated suction pump. He spoke of the value of the new type of gate valve stuffing box now supplied by Jenkins and Ludlow which could be tightened with a special type of box-wrench from the street level, and also of the improved Palmetto and Allpack packings.

HAROLD L. BRIGHAM, Supt. Water, Marlboro, Mass., spoke highly of the improved Allpack packing which was very flexible and round, rather than square shaped. He stressed the value of portable centrifugal pumps for general utility and their unit constituted one piece of equipment that they had refused to lend out.

NELSON BOARDMAN, Asst. Supt., Water Works, Danvers, Mass., said that he could concur with all of the favorable comment on the utility of meter recording equipment. In Danvers they had used a similar device to the Meter-Master for several years, the results being about the same as those reported. In consequence

Sidney S. Anthony, Supt., Augusta (Maine) Water Distr.

W. J. Scott, Hartford, Conn., Vice Pres., N. E. W. W. A.

many oversized meters had been replaced with more accurate meters and now it was the practice to make tests on all new services of consequence before selecting the meter for the service.

Mr. Boardman told of a method developed in Danvers for emptying mains before making a cut, thereby keeping the water spill in the trench to a minimum. The scheme involved the use of an air compressor attached to an open hydrant. The air injected forced the water out of the main through another open hydrant at the far end of the cut out section. (In a forthcoming issue the scheme employed in Danvers will be described in some detail by Messrs. Esty and Boardman.—Editor).

"Handling Consumer Complaints"—Was the topic opened by MR. MELLEY, of Milton, Mass., who said that leaking toilet tanks and fixtures had been found to be the cause of about 90 per cent of the complaints of excessive water bills. In answering complaints of taste or odor he had learned that much could be accomplished, by a sympathetic examination of conditions and sampling the water. Such psychological treatment seemed to satisfy the consumer that something was being done to correct the condition and the complainant became satisfied. He pointed out the value of "a pleasing and understanding" voice on the 'phone in answering complaint calls.

M. T. COOK, Supt. of Water, Newton, Mass., in presenting his experiences, had found the psychological process in answering taste or odor complaints to be the most satisfying solution.

S. S. ANTHONY, of Augusta, Me., said that it had been suggested in WATER WORKS AND SEWERAGE that "in a pinch," taste troubles could be blamed on the consumer's radio grounded to his water pipes. He had occasion to try the scheme shortly afterward and interestingly no further complaint was heard.

Chlorine Tastes—The chairman asked what concentration of residual chlorine could be carried in waters without causing taste complaints? The answer coming from W. J. Scott and L. H. Enslow indicated that the type of water (its purity) would largely determine the limit of residual chlorine above which it could be detected. In order to carry residual chlorine over the entire system for its desirable effects, but at the same time insure against taste complaints, the ammonia-chlorine process had been most effective.

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Harry H. Hendon Twice Honored

H. H. Hendon

Harry H. Hendon, Sanitary Engineer of Jefferson County and Birmingham, Ala., who, as a very young engineer has distinguished himself in sewerage construction in the community he serves, was recently recognized as a leader in his profession when on December 20th he was elected President of the Alabama Section of the American Society of Civil Engineers.

Another honor will also have been bestowed upon Mr. Hendon, about the time that this issue comes from press. On January 15th he will receive the Kenneth Allen Memorial Award from the New York State Sewage Works Association as the author of the outstanding paper of the year. The paper in question—"The Shades Valley Chemical Precipitation Plant at Birmingham, Ala."—which appeared in the March 1935 issue of WATER WORKS AND SEWERAGE, described Birmingham's newest, most efficient and attractive sewerage treatment plant, designed and built under the author's supervision. Reasons for selecting the chemical process of purification and preliminary results were set forth in his paper which has attracted international interest and many visitors to Birmingham.

It is seldom that a member so young is honored with the presidency of an A. S. C. E. section. And, it is the first time that the Kenneth Allen Award has gone to a non-resident of New York State. It is rare that such a young engineer has to his credit the design and construction of trunk sewers and four treatment works serving political subdivisions the size of Jefferson County and Birmingham, Ala. Rarer, still, is the sum total that the city and county has to show for each dollar expended for its most modern types of sewerage betterments completed since 1932 under Mr. Hendon's supervision.—L. H. E.

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Donaldson Joins New York City Department of Sanitation

W. Donaldson

Wellington Donaldson severed his connection with Fuller and McClintock, Engineers, on December 7th to accept the recently created position of Sanitary Engineer, Sewage Treatment Operations.

In his new work Mr. Donaldson will have charge of operations and personnel at the existing and projected sewage treatment works of New York City. The new 35 M.G.D. Coney Island Plant, placed in operation during the late summer is operated as a plain sedimentation in winter and as a chemical-precipitation plant in summer. The 180 M.G.D. Wards Island activated sludge plant, started some five years ago and left uncompleted, will be ready for operation within the next 18 months. Other plants under design include the 40 M.G.D. Tallman's Island activated sludge plant, to serve the North Shore of Queens, and the 65 M.G.D. Jamaica activated sludge plant for the Jamaica Bay section, where fine screening is now the treatment, plus chlorination in summer.

Mr. Donaldson, who began his career with the Knoxville (Tenn.) Water Company in 1901, went to the Birmingham (Ala.) Water Company in 1906. In 1908 he became Sanitary Engineer and Chief Chemist, supervising water treatment for the 30 properties of the American Water Works & Electric Company in 14 states. Since 1920 he has been a member of the staff of Fuller & McClintock, Engineers, of New York City as specialist on water purification and sewage treatment, during which time his firm designed and started in operation many of America's most important water and sewage treatment plants—30 of the former and 40 or more of the latter—including those at Richmond, Kansas City, Memphis, Buffalo, New York City (Wards Island), New Haven et al.

WATER WORKS AND SEWERAGE wishes the "Duke" (of Wellington) success in his new undertaking; but, knowing him as we do, feel that this wish is merely a way of saying—So be it!

Adolph Wandfluh, Operator Sewage Treatment Plant, Monroe, Wis., Conducting Plant Tests with the "Odeeometer."

THE "ODEEOMETER"—ITS PLACE IN THE CONTROL OF ACTIVATED SLUDGE PLANTS

By LEWIS H. KESSLER*
Madison, Wis.

ONE of the short-comings of the activated sludge process of sewage treatment has been the lack of suitable tests that can be conducted in a short period of time by the plant operator and, thereby, serve as an immediate guide in the control of plant operation. The smaller plants in particular have been operating under this costly handicap, where usually trained operator management or supervision is lacking. Visual appearance of the sludge, its settling characteristics, dissolved oxygen carried in plant aerators and limited analytical results obtained on the influent, mixed liquor and effluent have been about the only guides used. The first three are often the only tests conducted and if the others are run, the results are revealed too late to be of any immediate benefit to the operator who finds that his plant is getting into difficulties. For a number of years the writer has searched for some method of testing whereby the plant operator could promptly determine the immediate condition of his plant. To do this, a means must be available whereby the operator can obtain the following factors:

1. The immediate free oxygen requirements of the particular raw sewage-activated sludge mixture.
2. The condition or activity of the particular sludge.
3. The incoming sewage load on the plant, comparable with the 5 day B.O.D.
4. The stage or progress of oxidation of the sewage sludge mixture.
5. The time required for effective or efficient treatment.

If the operator can know these facts, he is in a position then, and then only, to act and be able to produce effective and efficient purification with accompanying economy.

*Assistant Professor of Hydraulic and Sanitary Engineering—University of Wisconsin.

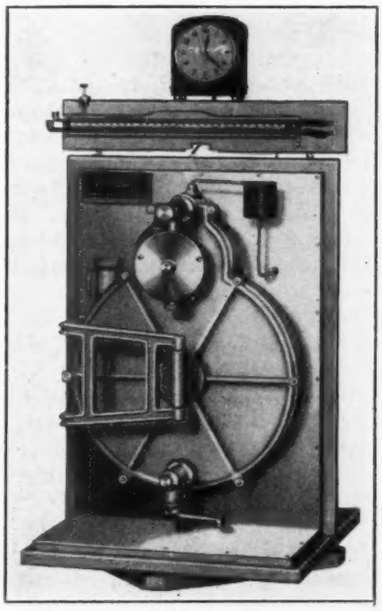


Fig. 1.—The "Odeeometer"

A Theory and New Test Method

It is believed, in general, that a theory and apparatus that provides a method of calculation and measurement of the five items named above will be of interest to engineers, chemists and operators having to do with the design or operation of activated sludge plants.

This paper is by nature a short description of a new theory concerning the mechanism of the activated sludge process and also a new apparatus or tool designed to assist the operator in applying the theory to the operation of his plant. This piece of laboratory equipment permits a rapid determination of the highly significant rate of usage of free oxygen by sewage and sewage-

sludge mixtures, and also oxygen demand values revealed by the direct absorption method. The theory and apparatus, known as the "Odeeometer" (Oxygen Demand Meter) was developed by Carl H. Nordell of the Advance Engineering Company, Chicago, primarily for the purpose of testing the condition of activated sludge-sewage mixtures by evaluation or measurement, in parts per million per hour, the free atmospheric oxygen utilized by sewage-sludge mixtures undergoing aeration. Buswell and Burtle (Sewage Works Journal, Vol. 7, No. 5, Sept., 1935) have used the machine in investigating oxygen absorbed by sewage and strong industrial wastes only.

To distinguish the oxygen demand, in p.p.m. per hour as measured by the machine, from the well known 5-day Biological Oxygen Demand (B.O.D.) it has been designated the "Nordell Number" or (N), because of important work done by Nordell in 1917 while engineer of design for the Milwaukee Sewerage Commission. The writer and his students first worked with the original machine in Nov., 1934, and has followed the development of it and used the meter in experimental investigations since that time at several sewage treatment plants, as well as in the laboratory of the University of Wisconsin.

The "Odeeometer" is particularly adaptable to secure a rapid determination of the condition or "activity" of activated sludges and an evaluation of the sewage load on the plant comparable with the B.O.D.—the complete test being made within one hour. Computations based on measurements obtained with this machine also indicate the stage or progress of oxidation of any sewage-sludge mixture at any point through the plant.

In a paper "Oxygen Utilization by Activated Sludge" (Sewage Works Journal, Vol. 7, No. 5, by L. H. Kessler and M. S. Nichols), which is now available as Univ. Wisc. Eng. Exptl. Sta. Reprint No. 42, a new conception of the mechanism of the activated sludge process has been described in detail. The theory was based on an extensive experimental investigation on the characteristics and behavior of sewage-sludge mixtures. In their paper the writers suggested a new theory, verified by experiment, which is believed to be of value in the design and control of activated sludge plants. A chemical method or technique has been developed and described for the determination of the rate of utilization of oxygen by raw sewage activated sludge mixtures after any period of time during the treatment process after the sewage is inoculated with return sludge and the aeration process started. The method used consists essentially of noting dissolved oxygen depletions in sewage-sludge mixtures over short periods of time and converting to parts per million per hour. This method was made possible due to a technique involving the use of copper sulfate solution as a coagulation and flocculation agent and as an inhibitor of interfering biologic action. The suggested method is simple but time consuming and the operator is limited thereby in the number of determinations that can be made. It is fully appreciated that the rate of usage of oxygen can be obtained easier by a direct absorption machine such as is the new Nordell "Odeeometer."

Principle of the "Odeeometer"

The principle upon which the machine operates is this: If a mixture of raw sewage-activated sludge completely saturated with dissolved oxygen from air then be subjected to further mechanical mixing in a container shut off from the atmosphere, in the presence of some surplus air available for further oxidation, the oxygen demand will be measured by the decrease in the volume of the original quantity of oxygen present in the air within the closed container. This decrease in the volume of the original quantity of oxygen present can be determined at the end of any desired period of time by observing and timing the travel of a bubble in a level glass tube, of known volume, connected to the closed container.

Since carbon dioxide is given off by the sewage-sludge mixture as oxygenation proceeds, provisions are made for absorption of this gas in a solution of sodium or potassium hydroxide contained in an auxiliary tank. Therefore, it is basically a device which measures the volume of oxygen utilized by direct absorption of atmospheric oxygen. Then, the decrease in volume of oxygen, measured in the calibrated bubble tube, can be converted quickly into weight of oxygen and, therefrom, into parts per million per hour.

Component Parts

Figure 1 pictures the front view of the machine and Figs. 2 and 3 are diagrammatic sketches and cross-section, showing the component parts.

The features of the machine are as follows:

A cylinder or main drum about 4,200 ml. in volume, with an air dome integral with the top of the drum, contains a paddle-wheel motivated by a direct connected reducing gear and electric motor. The paddle wheel rotates the contents of the drum and brings them into contact with the air in the dome. The drive shaft of the paddle wheel also rotates solid metal discs that revolve in a small circular solution tank on the front of the machine which contains the caustic soda solution. This solution tank is connected to the air dome of the main drum by a horizontal passage way extending through the air dome from front to rear. When both ends of this duct are open to the atmosphere, air can flow into the dome and oxygen is then available for the mechanical aeration of the sewage-sludge mixture. When the ends of the duct are stoppered, the main drum, air dome and solution tank provide an air tight container in which the sewage-sludge can be subjected to mechanical agitation. The carbon dioxide can pass through the connecting duct and is absorbed by the caustic solution on the surfaces of the revolving discs. Baffles are provided in the duct so that mixed liquor that is lifted by the paddle wheel can not enter the caustic solution tank.

Small diameter metal tubing leads from air dome, through a needle valve control, to the calibrated glass "rate" tube horizontally mounted at the top of the machine. Likewise tubing from a temperature well in the main drum is connected to a similar glass "temperature" tube of smaller diameter located above the "rate" tube. A centimeter scale common to both rate and temperature tubes is mounted between these respective tubes. An electric clock reading in hours, minutes and seconds is supported conveniently above the scale and glass tubes, so that the eye can easily and simultaneously catch the time interval and the respective location of the bubble in its travel in the glass tube. A few drops of red manometer oil is used to provide a suitable bubble in both rate and temperature tubes.

As auxiliaries, the rate and temperature tubes connect with metal tubing that is built in the form of a coil so that fluctuations in the bubble travel will be "dampened" and the movement of the bubble will be uniform throughout the travel. In the needle valve assembly that controls the operation of the bubble travel, metal bellows are so connected through another needle valve, that after a reading has been taken of the bubble

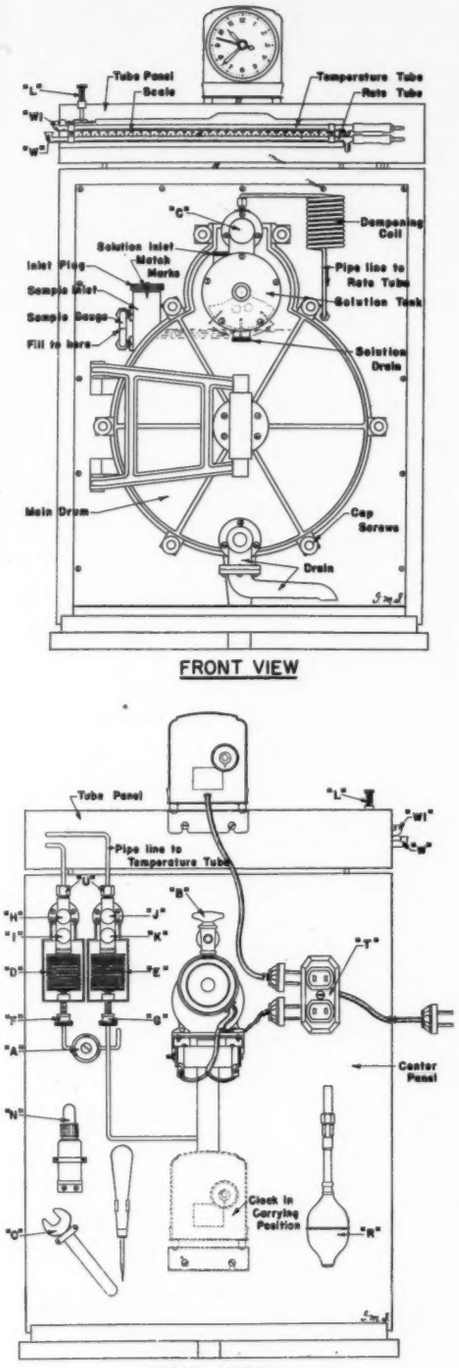


Fig. 2.—Diagrammatic Sketch of "Odeeometer" Front and Rear

travel as it advances under atmospheric pressure from the zero end of the scale towards the air dome, the bubble travel can be stopped at any point. By operating the needle valves and bellows, the bubble can be forced back through the tube to the starting point. In case the operator fails to close the needle valve as the bubble approaches the connecting piping, the oil of the bubble drops into a small well trap which keeps the oil from clogging the small metal tubing. The entire apparatus is securely and conveniently mounted in a portable case.

The main drum can be filled quickly with sewage-sludge mixture because a water level sight glass is mounted on the main drum so that the proper liquid elevation can be assured in order to obtain thorough mixing and circulation of tank contents.

Operation of Machine

To determine an oxygen demand curve for a sewage-activated sludge mixture the correct procedure follows.

Remove front and rear shells of carrying case and glass tube panel and electric clock. With the rubber bulb, blow out all pipe lines to assure no stoppage in the lines. Replace piping connections with wrench and make these air tight. Erect glass tube panel and clock on top of machine panel. Plug in electrical connection and start the clock. Level tube panel, open valves "A" and "B" and insert manometer oil or bubble fluid, with eyedropper, into Well "W" of the rate tube. Close valve "A" and open needle valve "H" and use adjustment screw "F" slowly to move bellows "D" and draw the bubble fluid the length of the tube thereby wetting the inside diameter of the tube. Close screw "H" to cut bellows "D" off from the rate tube, after bubble has been set near the end of the rate tube for an initial reading; then close valve "H". To insert bubble in temperature tube, open valves "J" and "K" and add drops to well W_1. Close valve "J". Adjust bubble to initial position by screw "G" and close valve "K". Valves "K" and "I" open the bellows "E" and "D" respectively to the atmosphere to permit refill of bellows with air when required. Valves "H" and "J" shut off bellows "D" and "E" from "rate" and "temperature" tube respectively.

Place 30 ml. of 10 per cent sodium hydroxide solution in the solution tank, leaving stoppers "B" and "C" of the air duct open. Pour about 4,200 ml. of the sample of mixed liquor to be tested into the "Main Drum" through sample inlet. Replace the plug and draw up tightly until "match marks" or indicator are in line. Note: A definite volume of activated sludge can first be placed in the main drum and a known volume of sewage added. However, a record must be kept of these quantities. Start motor with switch on rear panel to permit aeration of sample to take place since valve "B" is open and rubber stopper "C" has been removed and air chamber is open to the atmosphere. Saturation of the sample with dissolved oxygen takes place quickly and it is believed that even with strong sewage and large percentages of sludge floc, the saturation is complete in from two to three minutes. This, however, should be determined at each plant.

The rate of oxygen absorption is measured by the distance of bubble travel in centimeters after a one-minute period multiplied by the "rate tube" constant shown on well "W". For the machine used in the tests shown in this paper the constant is 1.78. Therefore, if the bubble travels 28 centimeters in one minute, then $28 \times 1.78 = 49.8$ parts per million per hour of oxygen absorption or oxygen demand.

To obtain the *rate* of oxygen absorption, insert stopper "C", open valve "A" connecting air dome with the rate tube and close valve "B". The initial readings of the bubbles should have been recorded and the time noted the instant valve "B" was closed. When time period of the observation is complete, snap valve "A" shut and final reading of bubble travel can be made at leisure. For further aeration of the sample rubber stopper "C" is removed and valve "B" is opened.

To correct for a change in temperature in Main Drum, set bubble in "temperature" tube on an even division preferably at 5 or 6 centimeters to allow for either expansion or contraction in volume of the air in the main drum. If during the period of observation for rate of oxygen absorption the temperature bubble moves outward, the total distance of bubble travel should be added to the distance of bubble travel in the rate tube.

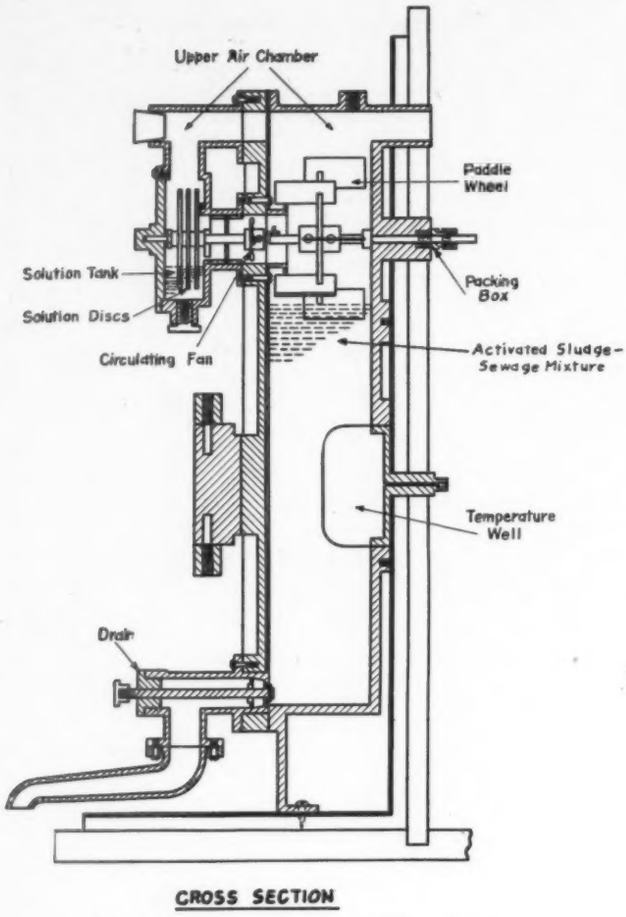


Fig. 3.—Section Through "Odeeometer"

If the temperature bubble moves inward during the period of observation, then the bubble travel should be subtracted from the total travel of the rate bubble.

After completing observations on the sample, the interior of the main drum should be thoroughly cleaned and sodium hydroxide solution drained out and the tank thoroughly rinsed.

The Oxygen Utilization Curve of Raw Sewage-Activated Sludge Mixtures

In order to show the application of the above described machine to sewage plant control, it is necessary to examine a few typical curves that reveal the rates of oxygen usage.

The curves shown in Figs. 4 and 5 were determined by the chemical method mentioned previously in this paper. Many studies indicate that the direct absorption machine or "Odeeometer" provides means for determining similar curves.

Figure 4, August 23, 1934, shows results of oxygen demand tests obtained on sewages of different strength in separate tanks being treated by activated sludges that were *not* identical in quantity or activity. As the tests for rate of oxygen absorption proceeded, samples were taken of the mixed liquor and B.O.D. determinations were made, but of course were not available until August 28th. On August 24th, Fig. 5, sewages of different strengths in different tanks were aerated after inoculation of these sewages with identical sludges in both volume and suspended solids. The curves give a picture of what happens to any unit volume of mixed liquor as it passes through an activated sludge plant.

Just before treatment starts in any plant there is a quantity of return sludge with a low oxygen demand and a quantity of raw sewage with usually a low oxygen demand and a high B.O.D. At zero time period of treatment on the curve, return sludge and raw sewage are being mixed together and the aeration process started. At this point, the rate of oxygen absorption (Nordell Number) is at a maximum, but instead of immediately decreasing as aeration proceeds, this rate remains constant for some time. It was found that the length of this period of constant rate of absorption of free oxygen varies directly with the amount of sludge and strength of sewage, being less in time for an increase of sludge and more for an increase in strength of sewage, other factors remaining constant.

After holding constant for some time, the rate of oxygen absorption decreases abruptly, first at a very high rate. Then as aeration proceeds, the rate of reduction decreases until after several hours of aeration the rate of usage of oxygen is almost constant.

Figure 4 indicates that as long as the maximum rate of absorption (M) remains constant, the B.O.D. of the supernatant of the mixed liquor is decreasing at an exceedingly fast rate and as soon as the rate of oxygen absorption decreases, the decrease in the B.O.D. of the treated liquor takes place very slowly. If Ridenour's curves (Sewage Works Journal Vol. 7, No. 1, Jan. 1935) are plotted to the same ordinate they would be almost identical to these curves except that for his curves the period of rapid B.O.D. reduction lasts only about five minutes, whereas the period of the August 23rd test was about 60 minutes. This difference in time can be explained partially by comparing the strength of the raw sewage. Ridenour working with 185 B.O.D. as against 400 B.O.D. in the above test.

The tests shown in Figs. 4 and 5 indicated that it would be possible to arrive at an empirical equation that could be used to determine the strength of the sewage undergoing treatment by the activated sludge process, the condition of the sludge, and the progress of the treatment process. The equation is based on rates of oxidation in p.p.m. per hour (N), and was found to be as follows:

$$N = \frac{M}{C\sqrt{T} - S + 1} \qquad \text{Equation (1)}$$

where "*N*" is a variable indicating Nordell Number at the time "*T*". "*T*" is the time in hours reckoned from the instant sludge is first dosed with sewage and the aeration process started. "*M*" is the maximum Nordell Number possible for a given sludge. "*S*" the period

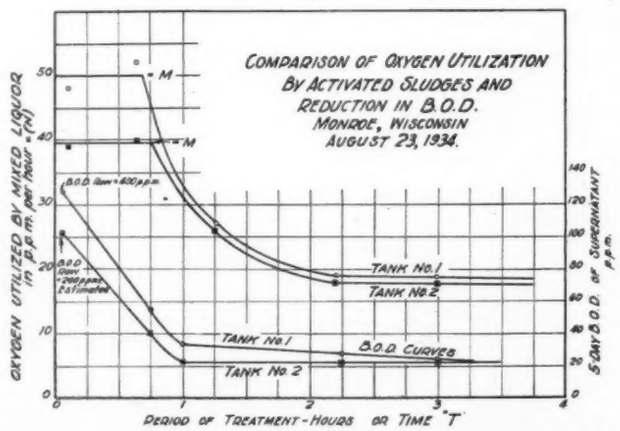
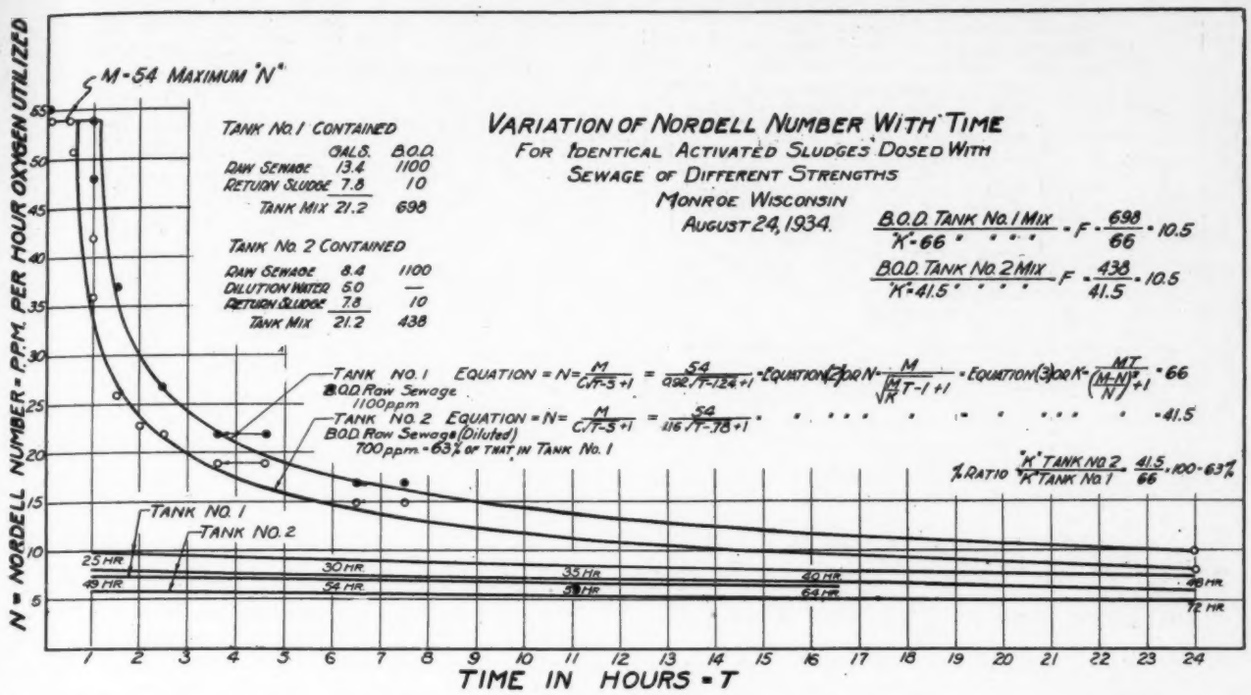

COMPARISON OF OXYGEN UTILIZATION BY ACTIVATED SLUDGES AND REDUCTION IN B.O.D.
MONROE, WISCONSIN
AUGUST 23, 1934.
OXYGEN UTILIZED BY MIXED LIQUOR IN P.P.M. PER HOUR = (N)
5 DAY B.O.D. OF SUPERNATANT P.P.M.
M
TANK No. 1
TANK No. 2
B.O.D. CURVES
PERIOD OF TREATMENT-HOURS OR TIME "T"

Fig. 4.—Oxygen Utilization by the Chemical Method vs. 5 day B.O.D.


VARIATION OF NORDELL NUMBER WITH TIME
FOR IDENTICAL ACTIVATED SLUDGES DOSED WITH SEWAGE OF DIFFERENT STRENGTHS
MONROE WISCONSIN
AUGUST 24, 1934.
M-54 MAXIMUM "N"
TANK NO. 1 CONTAINED
GALS. B.O.D.
RAW SEWAGE 13.4 1100
RETURN SLUDGE 7.8 10
TANK MIX 21.2 698
TANK NO. 2 CONTAINED
RAW SEWAGE 8.4 1100
DILUTION WATER 5.0 —
RETURN SLUDGE 7.8 10
TANK MIX 21.2 438
B.O.D. TANK NO. 1 MIX / K=66 = F = 698/66 = 10.5
B.O.D. TANK NO. 2 MIX / K=41.5 = F = 438/41.5 = 10.5
TANK NO. 1 EQUATION = N = M/(CT-3+1) = 54/(.092T-1.24+1) · EQUATION (2) FOR N = M/(M/K T-1+1) · EQUATION (3) FOR K = MT/((M-N)/N)+1 · 66
B.O.D. RAW SEWAGE 1100 PPM.
TANK NO. 2 EQUATION = N = M/(CT-5+1) = 54/(.116T-.78+1) · · ·

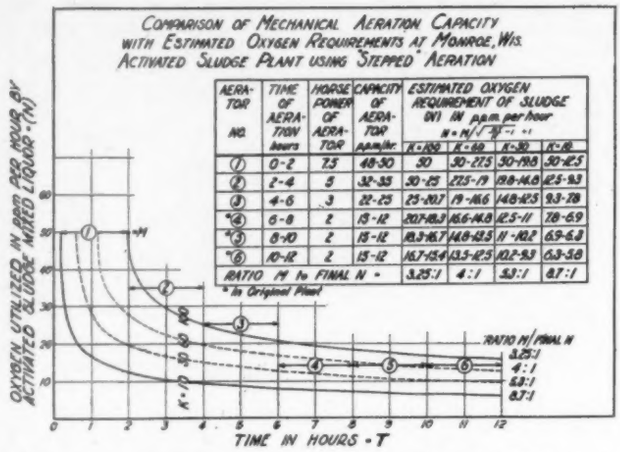

COMPARISON OF MECHANICAL AERATION CAPACITY
WITH ESTIMATED OXYGEN REQUIREMENTS AT MONROE, WIS.
ACTIVATED SLUDGE PLANT USING STEPPED AERATION
AERATOR NO.
TIME OF AERATION hours
HORSE POWER OF AERATOR
CAPACITY OF AERATOR p.p.m./hr.
ESTIMATED OXYGEN REQUIREMENT OF SLUDGE (N) IN p.p.m. per hour
N = M/T^0.3 = K
K-100
K-60
K-30
K-10
① 0-2 7.5 48-50 50 50-27.5 30-19.8 30-12.5
② 2-4 5 32-35 30-25 27.5-19 19.8-14.8 12.5-9.3
③ 4-6 3 22-25 25-20.7 19-14.6 14.8-12.5 9.3-7.8
*④ 6-8 2 15-12 20.7-18.3 14.6-14.8 12.5-11 7.8-6.9
*⑤ 8-10 2 15-12 18.3-16.7 14.8-12.5 11-10.2 6.9-6.3
*⑥ 10-12 2 15-12 16.7-15.4 13.5-12.5 10.2-9.3 6.3-5.8
RATIO M to FINAL N = 3.25:1 4:1 5.3:1 8.7:1
* In Original Plant
OXYGEN UTILIZED IN ppm PER HOUR BY ACTIVATED SLUDGE MIXED LIQUOR (N)
TIME IN HOURS - T
RATIO M/FINAL N
3.25:1
4:1
5.3:1
8.7:1

Fig. 6.—Comparison of Aeration Capacity with Estimated Oxygen Requirement (N) in "Stepped" Aeration

Application of "Odeeometer" to Sewage Plant Operation at Monroe, Wisconsin

Based on an extensive series of tests by the chemical method used in obtaining curves similar to those of Figs. 4 and 5, it was found that for Monroe sewage, carrying a heavy industrial load, largely whey, with B.O.D. of about 2,000 and using not more than 1,000 p.p.m. of suspended solids in the mixed liquor, that a maximum oxygen demand or condition of sludge "activity" of the mixed liquor would not exceed 50 p.p.m. per hour at the beginning of the aeration process. The plant had available a series of six aeration tanks each of about 43,000 gallons capacity. The aeration period based on sewage flow and return sludge would vary from 10 hours at the peak flow to 16 hours at the minimum flow, with and average aeration period of about 12 hours. Based on the 12 hours aeration period and an "M" of 55 p.p.m./hr., studies indicated that "K" would vary from 100 p.p.m. to 10 p.p.m. and the equivalent B.O.D. of raw sewage-sludge mixture from about 1,000 to 100. To picture this relationship, Fig. 6 is prepared which shows four oxygen utilization curves of K = 100, 60, 30, and 10 respectively. Therefore, for selection of aeration capacity the required rates of usage of oxygen are fixed and the required capacity of the mechanical areators becomes known. It will be seen that "stepped" aeration can be used in the oxidation process as indicated in the tabulated data of Fig. 6.

It will be observed that the plant will be loaded to the limit at maximum "K" of 100. This will endure for short periods only and it was thought the plant might possibly function without an increase in aeration capacity or in the number of aerators. At other sewage loads it was believed the aeration capacity would prove adequate.

From Table 1, the mixed liquor in aeration No. 1 had an estimated B.O.D. of 557, but this included 20 per cent return sludge with a B.O.D. of about 25. Hence the 557 B.O.D. represents only about 80 per cent of the sewage strength which must have been about 700 B.O.D. Note the progressive decrease in oxygen required "N" in each aerator after the Odeeometer test had been conducted on the sample from each aerator for about 0.15 hour or nine minutes. Also, that it was possible to discontinue test on aerator No. 4 and sample aerator No. 1 at 9:07 p. m. The maximum rate of usage of oxygen was about the same as in the afternoon but the sewage strength was only one-fifth of that during the industrial load. The next morning after about 12 hours aeration, the mixed liquor from aerator No. 6 was sampled and the ratio of "M" to "Final N" was 4+. Dissolved oxygen was maintained in all aerators with 3.2 p.p.m. in No. 1 to 6.0 p.p.m. in No. 6.

TABLE 1

Mixed Liquor From Aerator No.	Time of Test	Time After Start of Aeration in Odeometer (Hrs.)	Bubble Travel cm. per Min.	Observed Oxygen Absorbed in ppm/hr. Placed in Equation Numbers (2) or (3) "N"	"M"	"K"	"P"	Est. B.O.D. Mixed Liquor K x P
Mixing Channel	2:13	0.10	25.8	46.0	46			
	2:22	0.25	25.3	45.0				
	3:07	1.00	26.5	47.1				
	3:22	1.25	19.7	34.7		52	10.5	548
	3:37	1.50	16.8	30.1		54	10.5	568
	4:07	2.00	14.5	24.8		53	10.5	557
2	4:13	0.033	19.5	34.7	"N" at 4:11 p.m. By the			
	4:18	0.066	13.0	23.1	Chemical Method was 32.0			
	4:50:30	0.66	11.0	19.6				
	4:54:15	0.72	9.0	16.0				
	5:16	1.09	9.3	16.5				
3	5:25:15	0.078	20.5	36.5				
	5:29	0.133	14.6	26.0				
	5:35:35	0.241	12.8	22.7	Suspended Solids= 7%			
	5:41	0.333	12.7	22.6	Settling in 30 minutes.			
	5:50	0.516	12.7	22.6	550 p.p.m. by weight			
	5:54	0.55	8.9	15.9				
	5:56	0.564	7.8	13.9				
	6:02:15	0.688	8.2	14.6				
	6:55:30	1.575	6.5	11.9				
4	7:30:30	0.0841	15.8	28.2				
	7:33:30	0.141	7.8	13.9				
	7:41	0.267	6.2	11.0				
	7:50	0.417	6.7	11.9				
5	10:39	0.05	13.3	23.6				
	10:41	0.0833	6.7	11.9				
	10:53	0.284	4.7	8.4				
6	11:06	0.05	10.3	18.4	"Final N" Estimated at			
	11:10	0.116	5.0	8.9	11.0 p.p.m. per Hr.			
	11:33	0.50	3.9	6.9				
Effluent	11:43	0.066	4.0	7.12	5-Day B.O.D.(Dil.Test)= 25.			
	11:45	0.0834	2.1	3.75				
	11:49	0.142	1.8	3.2	Suspended Solids by Test			
	11:54:30	0.233	1.6	2.85	showed 44 p.p.m.			
	12:02:30	0.367	1.2	2.13				
Mixing Channel	9:11	0.0667	26.2	46.5				
	9:14	0.116	24.1	43.0	44.0			
	9:20	0.216	23.5	41.9				
	9:41	0.566	10.9	19.4		9.6	10.5	100.
	9:52	0.75	9.8	17.4		9.87	10.5	103.
	10:07	1.00	9.1	16.2		11.4	10.5	120.
	10:27	1.33	7.3	13.0		8.8	10.5	93.
Sept.21,1935 From #6 to the Final Tank	9:05:30	0.05	6.0	10.7	"Final N" by Chemical			
	9:08:30	0.10	3.1	5.5	Method at 9:02:30 = 7.2 ppm/hr.			
	9:19	0.275	2.2	3.9				
	9:20	0.292	2.3	4.1				

TABLE 2

Date of Test	Mixed Liquor From Aerator No.	Time After Start of Aeration in Odeometer (Hrs.)	Observed Oxygen Absorbed in ppm/hr. Placed in Equation Numbers (2) or (3) "N"	"M"	"K"	Estimated B.O.D. Mixed Liquor "K"x"P"
Sept.12 Only 4 Aerators Used-last two for conditioning sludge	Mixing Channel	0.10	61	61		
		0.583	28.7		15.7	165
		0.916	24.9		18.0	189
	2	0.10	16.1			
	3	0.10	16.1			
	4	0.10	13.8			
	Remark: Reduce return sludge lowering suspended solids to keep "M" within aeration capacity. Four aerators will treat weak sewage. Oxygen absorbed is too high in last aerator. Use all six aerators.					
Sept.13	Mixing Channel	0.10	40	40		
		0.45	28.2		12.7	133
		0.717	16.0		8.8	93
		1.00	13.7		8.5	90
	6	0.05	5.8			
		0.417	2.3			
Remark: Return sludge can be increased slightly. Ratio "M" to "Final N" = 7:1						
SEPT.14	Mixing Channel	0.10	14.0	14		
		1.00	14.0			
	2	0.10	15.0	After 4 hours	60.0 (Est. only)	630
	3	0.10	12.1	treatment		
	6	0.10	4.82			
		0.35	3.74			
Remark: Sludge pump suction partially clogged during night. Must increase suspended solids at once. "Final N" in last aerator is alright. Night flow properly treated.						
SEPT.15	Mixing Channel	0.10	52.0	52		
		0.50	21.0		8.18	86
		0.75	18.3		8.90	93
	2	0.10	18.3			
	6	0.10	2.67			
		0.333	1.78			
Remark: Plant operating alright. Sewage is weak.						
OCT.2 CHEESE DAY	Mixing Channel	0.115	31.3			
		0.30	22.2	22.2		
		0.40	20.5			
		0.80	18.7			
		1.00	18.7			
		1.55	21.8			
		1.80	24.0			
		2.38	26.0			
		5.00	13.35		77.0	810
		6.00	11.0		66.0	692
		7.00	9.6		57.0	600
Remark: "Spotty" "M" indicates poor sludge condition. Percent suspended solids being carried is too low to treat the strong sewage. Oxygen absorbed curve carried out to show time necessary for complete treatment in Equation(4) with "M" of 22, and ratio of "M" to "Final N" of 4:1 or "Final N" = 5.5 with "K" of about 60. Computed time "T"= 30 hours or about 2½ times available plant aeration period of treatment.						

TABLE 2

SUMMARY FROM TABLE 1

Mixed Liquor from Aerator No.	Sept.20 Time After Start of Aeration in Plant "T"=Hrs.	Calculated Oxygen Absorbed By Mixed Liquor $N = \frac{M}{\sqrt{\frac{K}{T} - 1 + 1}}$ with "K" of 53 and "M" of 46 ppm/hr.	Variation in Observed Values of "N" During First 15 minute period of oxidation in the Odeeometer ppm/hr.	Capacity of Respective Aerator ppm/hr.
1	0 to 2	46.0 - 24.8	46.0 - 24.8	50 - 48
2	2 to 4	24.8 - 17.8	34.7 - 23.1	35 - 32
3	4 to 6	17.8 - 14.0	26.0 - 22.6	25 - 22
4	6 to 8	14.0 - 13.35	28.2 - 13.9	15 - 12
5	8 to 10	13.35- 12.20	23.5 - 11.9	15 - 12
6	10 to 12	12.20- 11.30	18.4 - 8.9	15 - 12

A study of Table 1 and the summary in Table 2 shows that in general the decrease in sewage strength through the tanks is quite marked and the rate of utilization of oxygen (progress of oxidation) is in fair agreement with the theory and the capacity of the aerators with a ratio of "M" to "Final N" of from 4 to 5+.

Selecting values of "K" = 53; "M" = 46; and ratio of "M" to "Final N" = 3.8:1 or "Final N" = 12.0 and substituting in equation (4), the time required for treatment = 10.4 hours. If the ratio of "M" to "Final N" = 4.2:1 or "Final N" = 11.0, then time of treatment required would be 12.8 hours, in fair agreement with the test results. Odeeometer tests by the operator of this plant on samples from the final aerator on the way to the clarifier, showing values of "N" or oxygen demand above 12.0 p.p.m./hr., tell him that a "progress of oxidation" survey is necessary to correct the oxygen demand curve of the plant.

It is also believed that a partial log of tests conducted by the plant operator, Adolph Wandfluh, using the Odeeometer will be of interest together with the remarks relative to decisions made consistent with plant economy and efficiency as shown in Table 3.

Application to Sewer Rental

All sewer rental legislation recognizes that not only the quantity of sewage or industrial wastes but *quality* of waste affects the problem and cost of treatment and likewise the assessment. If an activated sludge is conditioned by aeration with the particular waste from the source under investigation, it is believed the use of such a sludge in the Odeeometer will be useful as a "yardstick" in determining "K" or the sewage load of the particular survey. This quality of sewage can then be rated in terms of the local domestic sewage. Since the machine determines the strength of the mixed liquor placed in the machine, it is essential that the amount of sludge used and amount of raw sewage added be known in order to calculate raw sewage strength or population equivalent. The logical amount of sludge to be used in the Odeeometer would be a volume or percentage similar to the return sludge in the plant. However, experimental investigation indicates that the theory and results obtained by the machine will apply to all sludge concentrations below 5,500 p.p.m. suspended solids.

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Much Needed School of Public Administration to Be Established

Through a gift of $2,000,000 from L. Nathan Littauer, retired glove manufacturer and a former member of Congress (1896-1906) from New York State, there is to be established at Harvard University a Graduate School of Public Administration, to promote the science and art of government and municipal administration. In making the donation, Mr. Littauer states "Governmental administration has in late years become highly specialized and technical and the true welfare of the people demands a special trained individual, imbued with ideals and ambitions, for our country's benefit."

In establishing the new school Mr. Littauer, in an interview, pointed to the fact that the type of civil-service prevailing in Great Britain had long been before him. The idea which led him to seek the establishment of a school of public administration for college graduates was "the training of men who really look upon government as a career—to set a new tone in American public life." If ultimately, a new conception of local government—involving, for example, the abolition of "Tammany Halls" from America—could be helped into being by the school, it would be only living up to the ideals, he had set for it.

The new school is expected to become operative by September, 1937. At present a commission composed of five leading educators, headed by President Dodds of Princeton, is making a comprehensive study, looking toward perfecting the plan and scope of the first school of its kind to be established in America.

[The above Picture Was to Have Accompanied the Report of the Annual Meeting of the Virginia Section of A. W. W. A. Which Appeared in Our December Issue. Through Error, Another Picture—That of the West Virginia Conference—Appeared With the Report Covering the (East) Virginia Meeting.—Editor.]

A STUDY OF FILTERING MATERIALS FOR RAPID SAND FILTERS

Part 7: Specifications for Filtering Materials

By JOHN R. BAYLIS*

Associate Editor

IN previous discussions on filtering materials and methods of washing filters, information has been given to show the need for modifying and making more explicit specifications for filtering materials. Many have realized for some time that specifications generally used in purchasing such materials have not been as thorough as they should like them to be. The difficulty was that there was not data to indicate the changes which should be made, but the writer believes that much of this needed information has now been published, and, that it is time to start making use of it in the construction of filter beds. After reviewing briefly what has been done in the past, new specifications for filtering materials will be offered.

Perhaps the earliest attempt to formulate means of determining the size of filtering materials, in order that the size as well as the quality of material may be stated in specifications, was that made by Hazen[1] in his work at the Lawrence Experimental Station of the Massachusetts State Board of Health. In the 1892 report of this board is presented a procedure for determining sand sizes. The method of testing sand was soon adopted by others, and sand specifications, defining the size of the material, were then written. In the early specifications for sand for rapid sand filters the main requirements were, (1) that the material should be silica sand with not more than 5 per cent by weight soluble in a solution of hydrochloric acid; (2) that the effective size and uniformity coefficient should be within certain limits. Frequently the specifications were a little more specific and stated the smallest and largest sizes of sand grains permissible. Some limited the 1 per cent size, and usually the specifications stated that there shall be not more than some certain amount of fine silt or loam in the material.

Standardization of Sieves.—One of the difficulties noticed in determining the effective size and uniformity coefficient of sand was that when material from some certain source was sieved in different laboratories, fairly wide variation in the results were reported. Burgess[2], in 1914, called attention to this, and his comments resulted in the appointment of a committee by the American Water Works Association to study sand sieving. This committee reported in 1918[3]. Owing to the use of wires of different diameters by the sieve manufacturers, which resulted in different size openings for the sieves designated to have a certain number of meshes per inch, the committee recommended that the sieves be designated by the width of the opening in millimeters instead of the meshes per inch. However, this method of designating sieves never came into general use.

The committee also recommended that only plain woven wire cloth be used, instead of the twilled cloth then used for some of the sieves of small size openings. A method for making the mechanical analysis of sand also was given. This method was substantially that given by Hazen, but was more explicit in some of the details. A 300-gram sample of the material was recommended for sieves 8 inches in diameter, and it stated that a mechanical shaker was required. A table was given showing the relation between size of opening and size of separation of the sieves. The ratio of the size of separation to opening was approximately 1.1, though it varied somewhat from this figure. The ratio was slightly higher for the small size openings and less for the larger size openings.

The committee's report is believed to have resulted in more attention being given to the manufacture of sieves. A few years later another committee on filter sand analysis was appointed by the American Water Works Association. This committee made its first report in 1924[4], and another report in 1925[5]. A specimen of sand was divided into a number of small samples and sent to various laboratories for analysis. The results obtained varied so widely, it was evident that more attention should be given to sand sieving.

Little Change in Specifications. Specifications still carry the Hazen effective size and uniformity coefficient, and about the only difference between recent specifications and those written years ago is that the requirements for the size of materials in most of them are defined more thoroughly. Such provisions as the following are typical of requirements other than for size of the material.

"The sand shall be composed of hard and durable grains and shall be substantially free from clay, loam, dust or other foreign matter. Not more than 5 per cent of the sand by weight shall be soluble in hydrochloric acid."

Improved Procedure for Determining Sand Size and Uniformity Coefficient. An improved method of determining the effective size of filtering materials to be used for rapid sand filters was given in the second of this series of articles on filtering materials (WATER WORKS AND SEWERAGE, May, 1934). This method was worked out from data obtained upon a number of different sizes and grading of materials, and also upon materials of various kinds. The determination of the various sizes of a material was by sieving the same as heretofore, but the method of determining the effective size and the uniformity coefficient has been changed. Most every one realizes the need for changing the Hazen method of expressing sand size to some more accurate method. The improved procedure gives an effective size close to that given by the Hazen method where the materials are fairly uniform in size. The effective size by the new method will average only about 5 to 10 per cent less than sizes determined by the Hazen method when dealing with the majority of the sands now in use in filter beds. Thus one does not have to think of the size of the material other than in terms of which we are already familiar. The uniformity coefficient, however, is different and may cause some confusion at first. The 1.0 per cent size of the material plays an important part both in the determination of the effective size and the

*Physical Chemist, Bureau of Engineering, Chicago.

uniformity coefficient. No size less than the 10 per cent size is taken into consideration in the Hazen method, which is a distinct fault in the method. The accuracy with which the improved method shows the relation of size of filtering material to filter performance should leave little doubt that it is an improvement over the Hazen method.

Probably the best manner of setting up the specifications in this article is to give specifications for furnishing all materials, including sand and gravel, and constructing the filter bed complete as though it was in one contract. This may be done in only a few instances, but he who draws the specifications can modify them so as to divide into two or more contracts. Usually the material is furnished by one contractor and placed in the beds by another. It should not be difficult, however, to divide the specifications into parts suitable for two or more contracts.

Too little attention has been given heretofore to the sizes of the materials at the junction of the sand and gravel, because more trouble develops at this point than any other part of the bed. The suggested specifications will define all the material from the coarsest gravel to the finest sand, giving especial attention, as will be seen, to the material near the top of the gravel.

The effective size of the sand cannot be given, as this will vary for different waters. There probably are waters where it is advisable to use sand as fine as 0.35 mm. for the effective size, and there may be other waters where sand as coarse as 0.60 mm. effective size should be used. The person writing the specifications will have to give, from previous knowledge or from a guess, the effective size desired. It is not practical to limit the size to some definite figure, though the range in size should be not more than 0.10 mm. There may be cases where it is desirable to make the range less.

The size and thickness of the coarsest layer of gravel will depend upon the kind of underdrains and the opinion of the designing engineer or purchaser of the material as to the size and thickness which should be used. The suggested specifications will assume that the smallest particles in the coarsest gravel will be about 38 mm. (1.5 inches) diameter. Where certain types of underdrains are used, it may not be necessary to use such coarse material. The method of computing the thickness of the various layers of gravel will be the same regardless of the size of the coarsest gravel used, for the equation (See WATER WORKS AND SEWERAGE, June, 1935, page 214) starts with material 1.0 mm. diameter and gives the distance below this point to any greater size of material. Perfect stratification according to size is assumed in the equation, which of course is not the case in the gravel bed as constructed. There must be a certain range in size in each layer of the gravel. The equation is for the ideal, and the gravel should be installed with as near the ideal grading as is practical.

Specifications for Furnishing Materials and Constructing Filter Beds

The contractor shall furnish the material and construct, ready for use, the filter beds in accordance with the provisions herein stated. Construction of the filter tanks with underdrains is not included in this contract, but the contractor shall take precautions to see that placing the filtering materials does not damage any part of the structure. Damages to the structure or equipment shall be repaired to the satisfaction of the engineer.

Gravel. The gravel shall consist of hard rounded pebbles with an average specific gravity not less than 2.50, and none of the particles shall have a specific gravity less than 2.25. It shall be free from thin, flat, or elongated pieces, and also shall be free from clay, loam, sand, and organic impurities of any kind. Not more than 5 per cent of the gravel shall be soluble when pulverized and digested for 24 hours in a strong solution of hydrochloric acid.

All material which will not pass through the openings of a 10-mesh standard sieve (U. S. Standard Sieve Series) having openings of 2.0 mm. shall be classified as gravel. The gravel shall be screened into sizes and placed in the filter in layers. The first 5 inches of gravel from the bottom upwards shall be composed of material which will pass through rounded or square holes 63 mm. in diameter and be retained on a sieve having holes 38 mm. in diameter.*

The layers of gravel above the bottom layer shall, when placed, conform to the following equation:

$$M = K \log D$$

M is inches below the material of 1.0 mm. diameter (assuming perfect stratification of the material according to size).

K is a constant.†

The contractor may use any method preferred in screening the gravel so long as the screening is thorough and the diameter of the screen opening in one sieve is not more than twice that of the next smaller sieve; that is, the diameter of the smallest particles in a certain layer shall be not less than one-half the diameter of the largest particles in the layer. The diameter of square openings is the diameter of a sphere which just passes through the opening. The contractor may use sieves which have larger openings than one-half the diameter of the next larger size, but not smaller.

The thickness of the gravel layers shall be computed by the above equation, using 12 for the constant K. If the diameter of the largest particles passing a 10-mesh sieve is 2.0 mm., the distance below the theoretical line of 1 mm. diameter size, assuming perfect stratification according to size, is 3.6 inches. The distance from the line of 1 mm. size to material of 4 mm. diameter is 7.2 inches, which will make the layer of material from 2 mm. diameter to 4 mm. diameter 3.6 inches. The thickness of the other layers shall be computed in the same manner.

Wire screens with square openings or plates with round openings may be used for screening gravel above 8 mm. diameter, but wire screens shall be used for lesser sizes. The average diameter of the particle is assumed to be that of a sphere which will just pass through the opening. This assumption applies only to particles large enough not to pass through a 10-mesh standard sieve.

Sand. The sand shall be composed of hard, durable, rounded grains obtained from bank or bed, and shall be free from flat particles and from clay, loam, dust or other foreign matter. When the sand is powdered, and digested for 24 hours in a strong solution of hydrochloric acid, not more than 5 per cent of the material shall be soluble.

The sand shall have an effective size between —— and —— diameter. (The blank spaces are for insertion of minimum and maximum effective sizes.) The

[*Note: The size and depth of the first layer of gravel is given merely as a suggestion. Where perforated pipe underdrains are used the coarsest gravel layer should extend from the bottom of the filter to at least the center line of the underdrains. Some may desire to have it extend from the bottom to the top of the underdrains, or even higher. Certain types of filter bottoms and underdrains make it unnecessary to use such coarse material. The thickness of the layer and the size of the particles for the first layer of gravel will have to be decided upon by the one writing the specifications. There may be certain types of filter bottoms where material 25 mm. diameter or even smaller will be satisfactory as the coarsest material.]

[†The constant K may be varied, but usually should be not less than 10 nor more than 14. In these specifications 12 will be used.]

uniformity coefficient shall be not less than ————. (The uniformity coefficient should be in excess of 15 for sand having an effective size less than 0.40 mm., and in excess of 20 for sand over 0.40 mm.) The 64 percent size shall be not greater than 1.6 times the 8 per cent size. A certain per cent sand size means that this percentage of the material by weight is of the size and smaller in diameter. There shall be enough coarse sand between the size of 1 mm. and 2 mm. diameter to make a layer the thickness computed by the gravel equation. (Where K is 12, the layer is 3.6 inches in thickness.)

To produce the grading desired, two grades of sand most likely will have to be used. One of the sands, of which only a small portion is required, should be composed largely of coarse sand; the other, which is the regular filter sand, is finer. At least 99.5 per cent of the finer sand shall pass a 10-mesh standard sieve having openings of 2.0 mm.

In the filter bed, there shall be 20.4 inches of sand less than 1 mm. diameter and 3.6 inches between the size of 1.0 mm. and 2.0 mm. diameter. (This is for a filter bed having a total sand depth of 24 inches. If a deeper or shallower bed is used the figures should be changed accordingly.) The depth shall be determined by measuring point 24.0 inches above the top of the gravel. The bed shall come to this height after being washed in the usual manner to expand the sand bed at least 30 per cent, and then cutting the wash water off slowly. The time of closing the wash water valve shall be not less than 30 seconds nor more than 60 seconds.

Procedure for Determining the Effective Size and Uniformity Coefficient. The sample sieved shall be representative of the total sand used in the filter bed. When two sands are used to give the desired grading, portions of the two materials shall be mixed in the desired ratio by weight and a sample of the mixed materials used for sieving. The percentages by weight passing the various sieves shall be plotted on logarithmic or logarithmic-probability paper, with the particle diameter in millimeters shown on one axis and the percentage by weight passing the sieves on the other axis. The 1, 2, 4, 8, 16, 32, and 64 per cent diameters of the material are taken from a line passing most uniformly through the points. The line shall be curved instead of extending straight between points where there is change in direction. Determine also the percentage of material by weight which is 1.0 mm. diameter and larger in size.

The effective size shall be determined by averaging the 1, 2, 4, 8, 16, and 32 per cent diameters, except that the maximum diameter considered shall be not more than 1.5 times the 1.0 per cent diameter. Should 1.5 times the 1.0 per cent diameter give a diameter less than the 32 per cent diameter, take all of the diameters mentioned which are less than this figure, and average. Then add all of the diameters less than the figure together with the diameter next greater than the figure, and average. After determining the two averages, compute the effective size proportionately between the two averages. To illustrate, assume that 1.5 times the 1.0 per cent size gives a diameter in which 12 per cent of the material is finer. Average the 1, 2, 4, and 8 per cent diameters, and also the 1,2, 4, 8, and 16 per cent diameters. If the averages are .500 mm. and .560 mm. diameter, respectively, the effective size is between these two figures. The difference between 8 and 16 is 8, and between 8 and 12 is 4 in. Add to the smaller diameter 4/8 of the difference in the two diameters.

.560 — .500 = .060
4/8 × .060 = .030
.500 + .030 = .530 mm. diameter, the effective size.

Should 1.5 times the 1.0 per cent size give a diameter in which more than 32 per cent of the material is finer, no diameter greater than the 32 per cent diameter shall be considered in determining the effective size, and the effective size shall be the average of the 1, 2, 4, 8, 16, and 32 per cent sizes.

The percentage of the material finer than 1.5 times the 1.0 per cent diameter is called the uniformity coefficient.

(Note: If this method of determining sand size and uniformity coefficient comes into general use, there will be no need for repeating the procedure in specifications.)

Modifications of the Suggested Specifications

The specifications which have been offered are intended for filter sand supported by gravel where the depth of sand is 24 inches. In some instances it may be desirable to modify them in various ways to obtain cheaper material, or material believed to be more suited for the particular water. There is not full accord that 24 inches of sand is the best depth to use. Also there may be cases where it is desirable to use crushed materials such as crushed quartz or crushed anthracite coal. Some material other than gravel may be cheaper or better for the coarse material in a few localities. These comments on the specifications are to aid in formulating special specifications to fit specific conditions.

Variation in the Depth of Filtering Material. Where it is desired to have the sand depth more than 24 inches or less than 24 inches, the only change needed in the suggested specifications is to substitute different figures for the depth of filtering material. Attention, however, should be called to the fact that, with a certain material, increasing the depth over 24 inches decreases the effective size of the material, and decreasing the depth increases the effective size. This was explained in the second article of this series (WATER WORKS AND SEWERAGE, May, 1934). Allowance for variation in the depth of material should be made by mentioning in the specifications the manner in which the effective size is to be computed. In order that materials in one place may be compared with materials elsewhere, some uniform procedure for taking the depth into consideration, such as that given in the second article of the series, should be used.

Use of Crushed Materials. There are a few filters in which materials other than sand have been used, such as crushed quartz and crushed anthracite coal. These materials probably will continue to be used to some extent. The effect of porosity should be taken into consideration where other than rounded materials are used. The porosity of rounded filter sand, as it settles back into place after washing, varies from about 42 to 46 per cent of the total volume. The porosity of crushed materials is higher and probably will range from 50 to 55 per cent of the volume. Data indicate that the effect of the porosity upon filter runs varies approximately as the 2.5 power of the per cent porosity. This should be considered only as an approximate figure, for shape of the material appears to have considerable effect. In varying the percentage porosity of rounded materials by compacting it more thoroughly after washing, the effect on the lengths of filter runs was slightly greater than the 3.0 power of the per cent porosity for the few tests conducted. Information obtained on varying the per cent voids of rounded material probably is not applicable to crushed materials.

Specifications which allow either rounded or crushed

materials to be furnished should define the method of determining the porosity and state how the porosity effect is to be taken into consideration. This was discussed in the third article of this series (WATER WORKS AND SEWERAGE, October, 1934). The porosity effect there given was the 2.13 power of the per cent porosity. Later work indicates that the 2.50 power is nearer correct. To obtain filter runs with crushed materials equivalent to those obtained with rounded materials, the effective size of the crushed material will have to be less than that of rounded material such as sand.

The particles of anthracite coal and of certain other materials are not of the same specific gravity, and this makes the determination of effective size more complicated, for the material in rapid sand filter beds does not stratify according to size so thoroughly as sand. It is desirable to take this into consideration in writing specifications, yet no method of so doing can be suggested, unless the material is put into a bed, washed, and a sample taken from the top two or three inches of the bed.

A procedure for determining the porosity of filtering materials was given in WATER WORKS AND SEWERAGE for October, 1934. Where there is knowledge of the per cent porosity it is not necessary to include the porosity test in the specifications. Then the specification may be nearly the same as for sand.

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New Jersey Department Liberalizes Sprinkling-Filter Requirements

THE outgrowth of detailed investigation conducted by the Engineering Division of the New Jersey State Department of Health has been a revision in the rules and regulations of the Department concerning the design and allowable loadings of sprinkling filters for sewage treatment works. A good part of the findings of the investigating force of the Department are set forth in a paper printed in the 1935 Proceedings of the New Jersey Sewage Works Association. (See also, WATER WORKS AND SEWERAGE for April, 1935—page 124—"Results of a Survey and Study of the Performance of Sprinkling Filters."—Ed.)

The new regulations make it permissible to apply to sprinkling filters 630,000 gals. of settled sewage per day for each acre per foot of depth—better than 100 per cent increase over the previous limits set at 300,000 gals. Chemical precipitation as a measure for reducing loadings on sprinkling filters and improving efficiencies of solids removal by final settling tanks is suggested.

The revised and amended rules embrace the following requirements and suggestions.*

General—

1. Sprinkling filters must be preceded by *efficient* sedimentation.
2. The minimum effective depth of the filtering media (to the top of the underdrains) must be not less than six (6) feet, and the preferable maximum depth is not more than nine (9) feet.
3. The filtering media must be from one (1) inch to two (2) inches in size; and the crushed stone shall comply with the official sodium-sulphate soundness test of the Association of State Highway Officials.
4. Arrangements for complete flooding of the filter, by sections, are desirable.
5. Underdrain ventilation shall be provided.
6. When the 5-day B.O.D. of the raw sewage exceeds 325 p.p.m., sprinkling filter treatment is not desirable unless preliminary sedimentation is supplemented by an additional method of treatment, such as chemical precipitation.
7. (a) The *volume* of sewage to be treated by a sprinkling filter shall not exceed 630,000 gallons per day per acre per foot of depth.

   (b) The *average* rate of application of sewage during the dosing period shall not exceed either of the following:

   (1) When the 5-day B.O.D. of the raw sewage is 215 p.p.m. or less, the allowed gallons per minute per foot is 1100.

   (2) When the 5-day B.O.D. of raw sewage is greater than 215 p.p.m. the gallons per minute per acre per foot must not exceed

$$\frac{215}{\text{5 day B.O.D.}} \times 1100.$$

   (c) The operating time of the filter should be not less than 20 per cent or more than 40 per cent of the day.

Secondary Tanks—

1. Sprinkling filters must be followed by settling tanks, in which the total detention period, (based on average daily flow) shall be not less than one (1) hour. Consideration should be given to aiding sedimentation and clarification by chemical precipitation; and, also to the installation of mechanical sludge collecting equipment.
2. Sludge disposal from secondary tanks.
   (a) If separate sludge digestion tanks are provided, sludge from the secondary tank should be discharged thereto, and a volume of not less than one-half (½) cubic foot per capita provided for this sludge.

   (b) Otherwise, secondary sludge should be discharged to glass-covered drying beds and the area, provided therefore, not less than one-quarter (¼) square foot per capita.

Nozzles—

1. Twin dosing tanks should be provided and have a common nozzle field.
2. The dosing cycle from nozzle shut-off to shut-off must not exceed fifteen (15) minutes.
3. The net terminal head on nozzles must be not less than one and one-half (1½) feet.
4. Half nozzles or equal must be provided at the sides of the filter bed.
5. Detailed information must be furnished in regards to the coverage efficiency of the nozzles.
6. Consideration should be given to means which will permit the removal from service of either half or any quarter of the nozzle field.

Traveling Distributors—

1. The filter retaining wall must not extend more than three (3) inches above the filtering media.
2. Valves must be provided to permit cutting out of service of any filter unit.

*Note: An official copy of "Sprinkling Filter Requirements" of the New Jersey State Department of Health may be had by addressing H. P. Croft, Chief Engineer of the Department, at Trenton, N. J.—Editor.

CENTRAL STATES SEWAGE WORKS ASSOCIATION

Discusses Disposal of Garbage With Sewage

AT the 8th Annual Convention of the Central States Sewage Works Association, the chief topic of interest was that of garbage disposal by ways of sewers and sewage treatment, four papers being presented in a symposium on this subject.

During the banquet, C. K. Calvert, Chairman of the Awards Committee, announced that the award for the best paper presented before the association in 1934 had been voted to the late J. A. Childs of Minneapolis, for his paper on "Oxygen Resources and Utilization in the Upper Mississippi."

What was listed on the banquet program as the highlight of the evening—an address by the Hon. Anton Carlson, Minister of Sanitation, Copenhagen, Denmark—proved to be one of the most cleverly perpetrated hoaxes it had ever been the privilege of most of the members to witness. The deception was effectively carried out by Alex Christensen, a professional magician who had been ably coached by the program committee.

The following officers were elected for the ensuing year:

President—O. M. Leonard, Sanitary District, Frankfort, Ind.

Vice-President—H. E. Babbitt, University of Illinois, Urbana, Ill.

Secretary-Treasurer—G. H. Radebough, Sanitation District, Urbana, Ill.

During the meeting a trip of inspection was made to the Urbana-Champaign Treatment Plant and the University of Illinois Sewage Testing Station, and State Water Survey Office and Laboratories were visited thereafter.

Technical Sessions

(President M. Starr Nichols, Presiding)

"Influence of Substate on B.O.D."—By W. L. LEA, Assistant Chemist and M. STARR NICHOLS, Chemist, Wisconsin State Laboratory of Hygiene, Madison, Wis.

Reporting on a study of dilution waters for the B.O.D. test, the authors had found the addition of potassium acid phosphate of primary importance. Amounts as small as 0.02 p.p.m. had a very striking effect in increasing the B.O.D. of samples. The question of the importance of standard bicarbonate in addition to other substances, to supply proper bacterial nutriment, had not been settled. Bacterial growth curves were shown correlating the effect of the various chemicals and amounts added.

"Digestion of Garbage with Sewage Sludge"—DONALD E. BLOODGOOD, Engineer in Charge, Activated Sludge Plant, Indianapolis, Ind.

Using tanks of 5 gallons capacity, operated on the fill and draw schedule, the author obtained data relative to gas production, tank capacity and rate of digestion. Using various types of sludge and varying the sludge-garbage mixtures, it was found that digestion takes place at a more rapid rate when garbage is present in the sludge mixture.

Daily charges of garbage and either primary or activated sludge, in which the garbage volatile was 33 per cent of the total volatile, digested for 9 days at 85 deg. F. had produced 562 cc. of gas (CO_2 content of 32.7 per cent) per gram of volatile matter added, with a resulting decrease of 59.9 per cent in volatile solids. The gas production per unit of volatile garbage solids has been found to be at least twice that produced from primary and activated sludges.

Mr. Bloodgood reported that, for about one month in the spring of 1935, more than 70 tons of garbage was ground and added to the crude sewage (47 M.G.D.) each day, without affecting operation of the Indianapolis plant.

"Disposal of Indianapolis Garbage with Sewage"—C. K. CALVERT, Supt., Sewage Disposal and Garbage Reduction, Indianapolis, Ind.

Mr. Calvert explained that at Indianapolis the problem was whether to continue the old garbage reduction plant, now inadequate, or to dispose of the garbage with the sewage. Experiments had been conducted adding ground garbage to the sewage at the entrance to the grit chambers, maintaining a careful sampling schedule, and keeping analytical records of B.O.D. and of plant performance. It had been found that the screenings were increased and a grit more organic in character had resulted. The organic material, however, could be washed out with water. Moisture content of the garbage solids averaged 82 per cent and that of the mixed solids from the sewage tanks 96 per cent. In addition to encouraging results on the small scale tests when mixing sewage sludge and garbage for digestion, the disposal of solids in the Indianapolis lagoons proved an easy problem. Aeration plant effluent, however, showed a noticeable deterioration and the air input had to be increased.

Figures indicate a gross cost of about $6.00 per dry ton for garbage disposal by reduction at Indianapolis, and a recovery of $3.00 for grease made the net cost $3.00. The cost of disposal by grinding and adding to sewage was only 40 cents per ton for grinding, with no figures available for increased air consumption and the cost of solids disposal. It had been decided for the present that the reduction plant should be continued as long as the price of grease remained as high as it currently was.

"An Investigation of the Amount of Garbage Which Can Be Digested with Sewage Sludge"—by F. H. WHITLEY, Graduate Research Assistant, University of Illinois.

Mr. Whitley reported on small scale laboratory experiments with various amounts of garbage and sewage solids. With equal dry weights, as volatile solids, no differences were found in digestion. When the amount of garbage represented more than 50 per cent of the volatile solids, acid production, slow-digestion and low gas production were the result.

"Methods of Dosing Sewage Tanks with Ground Garbage"—by H. E. BABBITT, Professor of Sanitary Engineering, University of Illinois.

Professor Babbitt worked mainly with a two-story heated digestion tank at 90 deg. F. He obtained 13 to

NOTE: The above report was scheduled for the December issue of WATER WORKS AND SEWERAGE but unfortunately space was not available and it had to be held for this issue.—EDITOR.

14 cu. ft. of gas per pound of volatile solids added. His work with Imhoff tanks showed it inadvisable to add sewage solids to gas vents or to the flowing through chamber. In gas vents a fibrous scum was formed and in the chambers proper settling did not take place even though the outlet end was baffled. Solids were carried through and were higher in the effluent than in the influent. He concluded that the two-story digestion tank gave the greatest promise of eliminating scum difficulties which are generally encountered in garbage digestion.

"The Treatment of Industrial Wastes in Connection with Domestic Sewage"—by L. F. WARRICK, State Sanitary Engineer, Madison, Wisconsin.

Mr. Warrick stated that the preferable method in approaching the problem of industrial waste, discharged to sewers, seems to be the utilization of the waste to the greatest extent possible and then some preliminary treatment of the residual before adding it to sewage. In Wisconsin over 140 canning plants present a problem. Generally, fine screening followed by coagulation with lime and ferrous sulphate is sufficient preliminary treatment. Six inches of sand over graded gravel is adequate for drying the sludge so produced, which, having a pH of above 9.6 dries without odor. The strong pea vine liquor was best eliminated by mechanical drying of the vines which produce a high grade cattle and stock food. For dairy waste treatment a filter of crushed stone, 8 feet deep, made in circular form and supported by linkwire fencing had proved an economical method of preventing these acid producing wastes from entering the municipal sewer.

"Mechanical Device for the Rapid Determination of Oxygen Utilization"—by L. H. KESSLER, Ass't Professor of Hydraulic and Sanitary Engineering, University of Wisconsin, Madison, Wis.

Devoting his paper largely to the use of the new Odeeometer ("Oxygen Demand Meter") in the control of activated sludge plant operation, the author gave a demonstration of the new device, assisted by Adolph Wandfluh, operator of the Monroe, Wisconsin, Sewage Treatment Works, where it is in constant use.

The principal advantages were pointed out as providing a measure of the immediate free oxygen demand of the raw sewage—activated sludge mixture; showing the condition or "activity" of the particular sludge; a comparison of the incoming sewage load with the 5 day B.O.D.; and the time required for effective aeration of the activated sludge. (Technical details as to the operation of the device are fully treated in Mr. Kessler's article which appears elsewhere in this issue.—Ed.)

"Diffuser Plate Studies"—by A. J. BECK, Principal Sanitary Chemist, Sanitary District of Chicago, Ill.

Mr. Beck explained that low pressure loss, very desirable from an operating standpoint, could be obtained by using air diffuser plates of high permeability. With greater permeability the bubble area decreases and this was illustrated by very ingenious photographs made of bubbles on the surface of plates under various air pressures. The size and uniformity of the bubbles had been determined against cross-section paper. From the Chicago studies, Mr. Beck concluded, there was no great loss in efficiency when using plates of high permeability and low pressure loss; whereas, there was an economy in aeration costs which justified their use.

"Magnetite Filters in Sewage Treatment"—by S. I. ZACK, Filtration Equipment Corporation, New York, N. Y.

Results at a number of installation where coarse grained magnetite filters are used, either as final treatment after trickling filters or after chemical precipitation, were cited by Mr. Zack. At Dearborn (Mich.), using lime and ferric chloride at less than $5.00 per M.G. and applying effluent to the filter at 1.74 gal./sq.ft./min., a removal of 92 per cent suspended solids and 75 per cent B.O.D. had been obtained over a 4 months period. At Perth Amboy, using no chemicals, a removal of 90 per cent suspended solids and 65 per cent B.O.D. was obtained at 0.8 gal./sq.ft./min. Due to the presence of industrial wastes at Perth Amboy the pH variation was 2 to 9 during a 24 hour period.

"Minneapolis-St. Paul Sewage Disposal Project"—GEORGE J. SCHROEPFER, Assistant Chief Engineer, Sewerage Commission, Minneapolis, Minn.

Mr. Schroepfer reported that at present, over 33 construction projects on the Twin-Cities sewage disposal project, involving chemical treatment, had been awarded and the total estimated cost would be about $15,000,000. Screen and grit chambers were already under construction, and the mixing and flocculation tanks had been designed. On the basis of the maximum of 70 per cent B.O.D. reduction, which is required by the conditions, it is expected that lime and chlorinated-copperas will be the coagulants used. Sludge disposal would be by incineration.

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Chemical Sewage Treatment for New Britain, Conn.

A chemical precipitation plant, to employ the Guggenheim process, is to be built by New Britain, Conn. The main elements of the plant are a mechanically-cleaned bar screen; pre-settling tanks (1 hr. detention); spiral flow air-agitated flocculation tanks (1½ hours of detention); final settling tanks (2 hr. detention); automatic chemical-feed apparatus; vacuum filters; and an incinerator for scum, screenings and sludge. Provision is made for the use of either quicklime, prestolite lime, chlorinated copperas, ferric chloride or alum.

Sludge from the settling tanks will be recirculated, to maintain about 1,000 p.p.m. of suspended solids in the flocculating tank, the surplus going to the pre-settling tanks. Sludge from the latter will be pumped to conditioning tanks for vacuum filtration.

Adoption of the process by New Britain followed experiments begun about June 1, 1935, with a 100,000 gal. plant built and operated by Guggenheim Brothers. Fuller and McClintock, New York City, are engineers on the project.

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Schenectady Plans to Enlarge Sewage Treatment Plant

Application for a PWA loan and grant has been filed for the purpose of remodeling and enlarging the Schenectady, N. Y., sewage treatment plant. Plans for increasing the plant capacity to 15 M.G.D. have been prepared and filed by Morris M. Cohn, Sanitary Engineer of Schenectady.

Six of the existing Imhoff tanks (8.5 m.g.d. capacity) will be converted into 1.5 hr. settling units, equipped with mechanical sludge removal mechanisms. Two heated 60 ft. × 24 ft. circular digestion tanks (1.32 cu. ft./capita) are to be added and three of the old Imhoff tanks are to be used for sludge storage. A 10,000 cu. ft. gas holder and a 75 K.W., gas-engine driven, generator will supply sufficient power for all plant uses. The settled sewage will be chlorinated before discharge to the Mohawk River. The cost of the project is estimated at $222,000.

HOURLY LOAD VARIATIONS IN RELATION TO SEWAGE TREATMENT PLANT OPERATION

By ELSON T. KILLAM*

New York City

THE wide variations in the hourly load arriving at sewage treatment plants, due to the combined effect of variations in sewage strength and in rate of sewage flow, have previously been discussed in an article by the writer in WATER WORKS AND SEWERAGE.[1]

Data then available were confined to two plants, both located in Georgia. Investigations recently conducted on two systems in New Jersey involving widely different conditions than those of the two systems originally described, indicate surprisingly similar load variations.

Tests of 24-hour duration with frequent flow readings and separate analysis of hourly or two-hourly samples emphasize the following conditions in these four systems:

1—A substantial portion of the total daily load arrives at the plant in a comparatively short operating period —see curves.

2—The hourly variations and per cent of the total daily load arriving at the plant in any given period are not markedly different regardless of whether the load be expressed in terms of flow and B.O.D. content—or, expressed in terms of flow and suspended solids content.

3—Load variations from hour to hour are surprisingly uniform regardless of the size of the system or other factors which might normally be expected to create widely different conditions.

4—Hourly distribution of load and variations therein have important effects on plant efficiency and on operating procedure with many types of treatment plants, particularly chemical plants. These variables emphasize the desirability of providing for flexibility in design to allow variable operation.

Studying the Load Variations

A convenient method of summarizing sewage load variations is by means of cumulative load curves. To obtain data for such a curve, samples should be collected throughout a full 24-hour period, preferably at intervals of 15 minutes or ½ hour. These samples should be proportionate to the flow and each group of samples comprising a period of one or two hours' duration should be separately analyzed. It is also essential to take flow measurements at frequent and coincident intervals. In this way the total pounds of suspended solids or B.O.D. arriving at the plant during each hour of the day, may be ascertained. Cumulative load curves may then be constructed by selecting, first, the hour at maximum load, and subsequently taking each consecutive hourly load in order of descending magnitude, and plotting of 24-hour curve. Loads expressed in terms of flow and suspended solids content, or flow and B.O.D. content, or both, may be used for the study.

Typical examples of such curves, showing data for the four systems investigated, are shown on Figures 1 and 2, the former being based on load determined by suspended solids content and flow, and the latter upon B.O.D. and flow.

Statistics, showing the type of system, average daily flow, tributary population, and other information, for the four systems investigated, are shown on Table 1.

*Associate, Alexander Potter Engineers, New York, N. Y.

[1]"Hourly Load variations as a Factor in Sewage Treatment Plant Operation"—WATER WORKS AND SEWERAGE; July, 1934; pp. 237-240.

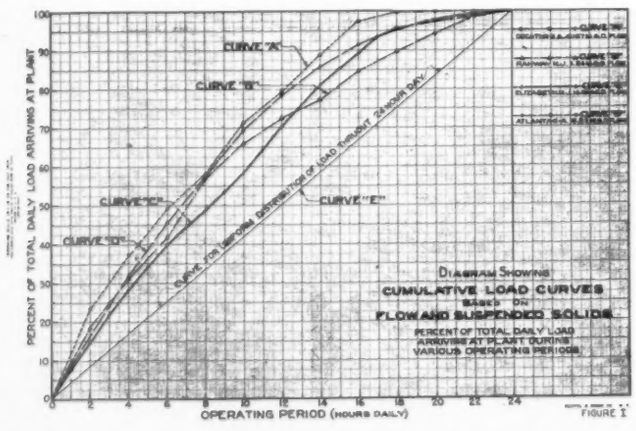

Fig. 1—Cumulative Loads, Based on Flow and Suspended Solids

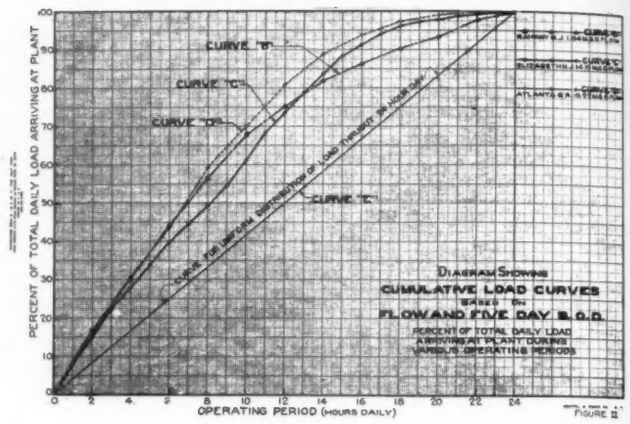

Fig. 2—Cumulative Loads Based on Flow and 5-Day Oxygen Demand

Similarity in Load Variations

In view of substantial differences in type and size of the four systems referred to in Table 1, the relatively small difference in the load developed in any given number of hours in each of the systems, is of especial interest.

The Decatur (Ga.) system, for instance, involved a sewage flow of only 0.16 M.G.D. with a population of only 2200 people in a strictly residential area, and with the most remote point in the area served only 2½ miles from the point of sampling on the trunk sewer.

On the other hand, the Elizabeth Valley System involved a total flow of 14.19 M.G.D. from a tributary system comprising several hundred miles of sewers serving 228,000 people. Remote portions of the system are at least 18 miles distant from the point at which flow measurement and samples were taken.

It might well have been expected that in such an extensive system as the latter, the variations would be smoothed out and greatly reduced in magnitude before the sampling point was reached by the passing flow. Comparison of all four curves, however, indicates that

TABLE NO. 1 — DATA RELATIVE TO CUMULATIVE LOAD CURVES

Curve Number	Location of System	Type of District Served	Average Flow—M.G.D.	Estimated Tributary Population	Date of Test Period	Distance from Sampling Point to Most Remote Point in System—Miles	Method of Flow Measurements *	Data Relative to Samples
"A"	DECATUR, GA. (Shoal Creek Outlet Sewer)	Strictly Residential; Separate System	0.167	2,200	4 p. m., Sat., Oct. 28 to 4 p. m., Sun., Oct. 29, 1933	2.5	90 deg. V Notch Weir	(a)
"B"	RAHWAY, N. J. (Rahway Valley Joint Trunk Sewer for 7 Municipalities)	Separate System; Residential, with some Industries and some Business Districts	1.84	23,000	3 p. m., Mon., July 23 to 3 p. m., Tues., July 24 1934	7.8	90 deg. V Notch Weir	(a)
"C"	ELIZABETH, N. J. (Elizabeth Valley Joint Trunk Sewer for 12 Municipalities)	Separate System; Residential, with some Industries and some Business Districts	14.19	228,000	2 p. m., Thur., Aug. 2 to 2 p. m., Fri., Aug. 3 1934	18.0	Venturi Meter	(b)
"D"	ATLANTA, Ga. (Main Sewer Entering Peachtree Creek Plant)	Combined System; Residential, with some Industries and some Business	15.22	110,000	8 a. m., Fri., May 3 to 8 a. m., Sat., May 4 1933	8.0	Recording Gage at Station Rated by Current Meter	(a)

* All Flow Readings at half-hour intervals.
(a) Samples collected at half-hour intervals—each group of four composited and analyzed.
(b) Samples collected at half-hour intervals—each group of two composited and analyzed.

in no instance, within a fixed number of hours of operation, does the total cumulative load arriving at the plant vary by more than 13 per cent. Examination of the curves also discloses that the distribution of the load, based on suspended solids, agrees very closely with the load based on 5-day B.O.D.

What It Means

The similarity of these curves indicates that load variations in substantial proportions may be expected on every sewerage system. These variations and their effects are accordingly important in the design and operation of sewage treatment plants; in the measurement and evaluation of treatment plant efficiency; and, in the collection of river samples below sewer outlets during investigations of the pollution of receiving streams.

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Pittsburgh Equitable Adds To Research Staff

Pittsburgh Equitable Meter Company has recently added two new members to the Research and Product Development Section of its Engineering Department at Pittsburgh.

Mr. M. E. Cloran comes to his new position with a valuable background of practical engineering experience. A graduate from Harvard University (1928), he was first employed by Stone & Webster of Boston as a junior engineer. He advanced by successive steps to become plant engineer for the Atmospheric Nitrogen Corporation of Hopewell, Va., and more recently held a sales engineering position with the Consolidated Ashcroft Hancock Corporation of Bridgeport, Conn.

Mr. H. J. Evans, a graduate engineer of the University of Oklahoma, with a M.S. degree, has since been employed in the Geological Department of the Carter Oil Company and Humble Oil Company.

Messrs. Cloran and Evans will work in the physical laboratories of the company in Pittsburgh, under the direction of Chief Engineer Allen D. MacLean and the immediate supervision of Research Head L. M. Van de Pyl.

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Association Meetings Scheduled:

Jan. 15, 1936—**New York State Sewage Works Association.** (8th Annual Meeting.) Hotel Astor, New York City. Secretary, A. S. Bedell, State Department of Health, Albany, N. Y.

Jan. 15-17—**American Society of Civil Engineers.** Annual Meeting. Secretary, George T. Seabury, 33 West 39th St., New York City.

Jan. 16—**New England Water Works Association.** Hotel Statler, Boston, Mass. Secretary, Frank J. Gifford, Room 613, Statler Bldg., Boston, Mass.

Jan. 29—**New Jersey Section, A. W. W. A.** (General Meeting.) Hotel Stacy-Trent, Trenton, N. J. Secretary, P. S. Wilson, Glen Ridge, N. J.

Feb. 3-8—**Texas Water Works Short School.** College Station, Texas. Annual Meeting. Address, V. M. Ehlers, Austin, Texas.

Feb. 20—**New England Water Works Association.** Hotel Statler, Boston, Mass. Secretary, Frank J. Gifford, Room 613, Statler Bldg., Boston, Mass.

March 23-25—**Kentucky-Tennessee Section.** Lexington, Ky. Secretary, F. C. Dugan, State Board of Health, 532 W. Main St., Louisville, Ky.

April 1-3—**Canadian Section, A. W. W. A.** (Annual Convention.) Royal Connaught Hotel, Hamilton, Ont. Secretary-Treasurer, A. E. Berry, Department of Health, Parliament Buildings, Toronto, Ont.

April 7-9—**Indiana Section, A. W. W. A.** Purdue University, Lafayette, Ind. Secretary-Treasurer, John A. Bruhn, Indianapolis Water Co., Monument Circle, Indianapolis, Ind.

April 9-10—**Illinois Section, A. W. W. A.** Evanston, Ill. (Annual Convention.) Secretary-Treasurer, W. D. Gerber, Room 57, Chemistry Bldg., Urbana, Ill.

April 17-18—**Montana Section,** Butte, Mont. Secretary, H. B. Foote, State Board of Health, Helena, Mont. (Operator's Short School—April 15-16.)

April 21—**New England Water Works Association.** Hartford, Conn. Secretary, Frank J. Gifford, Room 613, Statler Bldg., Boston, Mass.

June 8-12—**American Water Works Association.** (Annual Convention.) Biltmore Hotel, Los Angeles, California. Secretary, B. C. Little, 29 West 39th St., New York City.

EDITORIAL

Can We Afford NOT to Line C. I. Pipes?

IN the future, water supply authorities will find it incumbent upon them to give increasing thought to the matter of protective linings for pipes used in water supply mains and distribution systems. The question to be answered is—Will it pay to go to the added first cost of using pipes centrifugally lined with cement or bituminous enamel in order to preclude corrosive (tuberculative) effects of the water, which depreciates the carrying capacities and, therefore, the value of water mains?

Observed depreciation in carrying capacities of Cast Iron pipes in service has been in many instances far more rapid than assumed or anticipated, when applying the widely accepted Williams-Hazen coefficients of predicted friction losses, with increasing length of service of Cast Iron pipes. Such a condition has been effectively revealed in the recent report by the Committee on Coefficients of Friction in Pipe Lines of the New England Water Works Association. This report, which appears in the September 1935 issue of the N. E. W. W. A. Journal, states that data on tar-coated pipe in 19 cities showed that the average value of the friction coefficient factor ("C") was but 64 after 30 years of service, whereas, a predicted value of 88 was to be assumed by designing engineers who may have relied upon the widely used Williams-Hazen tables. Expressed otherwise, the value of "C" had been found to have dropped to 88 after only 11 years of service, compared with the predicted service of 30 years before reaching that figure of depreciated capacity. As to distribution systems, taken separately, the report pointed out that in 8 of 10 systems the friction coefficient had dropped to a value of less than 50 after 30 years of service, as compared to the predicted value of 88. Thus, the observed figures could be translated into capacity losses of from 61.6 to 84 per cent instead of the predicted loss (Williams-Hazen Tables) of only 37.5 per cent. The highest losses observed were those for pipes in distribution systems, particularly the smaller sizes.

Due to the heretofore limited use of cement-line pipes and relatively short periods of actual service of centrifugally lined pipes, data on these were scanty. After 10 years of service, however, the observed value of "C" for such pipes had held at 134 to 136. And, was essentially the same as that of new centrifugally cement-lined pipe when calculated on the original pipe diameters before lining. On an old style 12 inch cement-lined main the observed "C" value was 104 after 41 years of service. For pipes centrifugally lined with Bitumastic enamels no data was presented by the committee, because of the too limited service, but hand coated pipes after 16 years had not deteriorated.

In view of the conditions cited and the repeated advocacy of cement lined pipes by such men of experience as Jas. Gibson of Charleston, S. C., Thomas Wiggin of New York City and others, and their use by several water companies on the strength of demonstrated value, it is difficult to understand why less than 10 per cent of the Cast-Iron pipe bought in very recent years has been lined pipe.

That Cast Iron pipe suffers only slightly from external depreciation in the ground or serious weakening from internal corrosion, has been well established. That it does suffer from tuberculation, and thereby depreciated carrying capacities in proportion to age and aggressiveness of the water, is likewise well established. In consequence, a genuine need for some form of protective lining seems evident to maintain sustained capacities, minimum pumping costs (friction head), and greater permanency of values in the major water supply investment.

That the use of lined pipe is subject to decision, based upon some knowledge of the aggressiveness of the particular water, is evident in the report of the committee which reveals the less important capacity losses of supply mains delivering unfiltered or alkaline waters and the decided relationship between pH values of waters and pipe capacity losses after years of service. For example, the 30 year loss at known pH value of the waters were—pH 8.0 = 30 per cent; pH 7.0 = 45 per cent; pH 6.0 = 85 per cent. Thus, the value of protection mounts with descending pH value, softness of supply and freedom from buffering organic or inorganic salts which tend to lay down natural protective coatings on the metal. Likewise, in dead ends where some putrefaction and attendant drop in pH values and corrosion occurs, protective linings become more important than elsewhere in a given system.

The question of the proportionate value of lined Cast Iron pipes is one to be decided for each individual case, or at least for types of water involved and location of the pipe in the system. In many cases this means that lined pipe will have a proven value for entire systems, and especially and more prevalently for extensions of mains and new feeder lines.

This brings up the question: Can lighter walled pipes be used for lined pipes and thereby render such pipes less costly in the beginning, as well as in the end.

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"More Time to Think"

REGARDLESS of one's political faith or opinion, the expressed wish of the wife of the President of the United States for this New Year of 1936 can well serve as a very worth while pattern for every individual. Mrs. Roosevelt, in reply to questions concerning her New Year's resolutions, said: "I am going to try to resolve to have more time to think."

It is not necessary to cite individual cases in the water supply and sewerage fields wherein the taking of more time to think would have resulted in sounder plans, better plant design, improved efficiency, more economical operation, happier public relations, or less criticism. Every reader who examines this page will, without question, be able to put his finger on one or more instances wherein the time spent in more thought and analysis would have yielded a worth while return on the investment of even such precious commodities as time and good judgment.

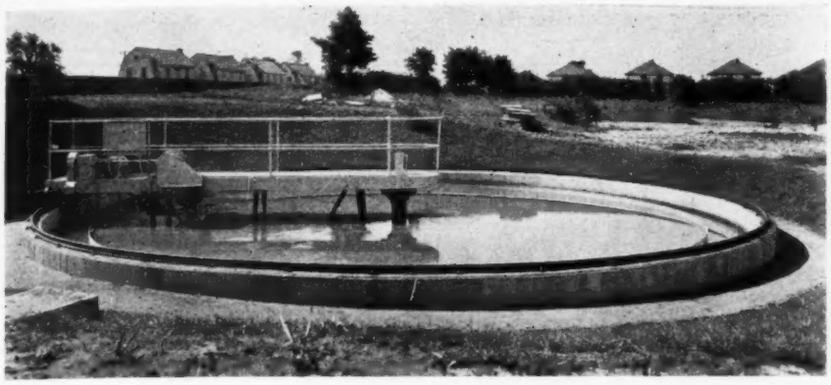
Over-enthusiasm, inexperience and faddism have been the chief obstacles to sounder practices in water works and sewerage design and operation. When a new style is created or a poorly evaluated new method is evolved, faddists rather than thinkers are likely to create the trends. The end result is that the conservatives become ultra-conservative and the majority become, in the main, copyists.

Is not the corrective for such a condition the giving of more individual thought and study to the problem at hand? Yes; the taking of *"more time to think"* in water supply and sewage disposal planning in 1936 and the years to follow.

EQUIPMENT NEWS AND LITERATURE REVIEW

Link-Belt Circuline Collector

Link-Belt Company of Chicago have recently announced a new addition to their established line of sludge collector mechanisms. The new "CIRCULINE" mechanism, for circular settling tanks and having a central feed, is driven by a motor at the outer end of a revolving supporting bridge. The collector proper is essentially the well known Link-Belt STRAIGHT-LINE mechanism employed for many years in rectangular settling tanks.



Link-Belt Circuline Sludge Collector Installation Merchantville-Pensauken Sewage Plant, N. J.

The squeegees on the flight of sludge scraper plates come in direct contact with the floor of the tank to insure positive cleaning and maximum sludge density in the central hopper. On their surface return to the periphery of the tank (in front of a scum plate below the traveling bridge) the sludge scrapers serve as positive skimmers which deliver to the scum trough. The speed of the mechanism and its travel around the tank have been held to a minimum in order to insure the least disturbance of the lighter sludges and to secure the maximum of free-settling. The mechanism is designed to give positive performance with equal efficiency on flat, sloping or conical tank bottoms.

Literature on the new Link-Belt CIRCULINE Collector states that it retains the operating advantages of the Link-Belt STRAIGHT-LINE Collector with the benefit of reduced construction costs. Features: Positive and prompt sludge and scum removal; slow peripheral speed of mechanism and positive circumferential drive.

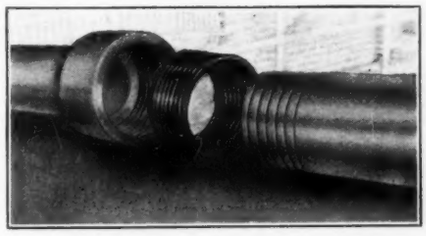
For descriptive literature and further information on the "CIRCULINE," address: Link-Belt Co., 307 N. Michigan Ave., Chicago, Ill.

"Flexlock" Pipe Joints

The "Flexlock" Pipe Joint for water, sewer and chemical lines, recently announced by U. S. Stoneware Company of Akron, Ohio., is a moulded rubber ring having numerous circumferential ribs (fins) which grip both the interior of the bell and the exterior of the spigot of the pipe to produce a flexible but tenacious and permanent *non-leaking, corrosion-proof* and *root-proof* joint.

The new joint was designed and developed by the B. F. Goodrich Company for the chemical and sanitary field with the co-operation of U. S. Stoneware Company.

The fins or ribs on the Flexlock rubber cylindrical ring are so designed that the pipe and ring slip home into the bell easily, whereas internal pressure, or pull, cause the fins to expand and increase their grip as they do.



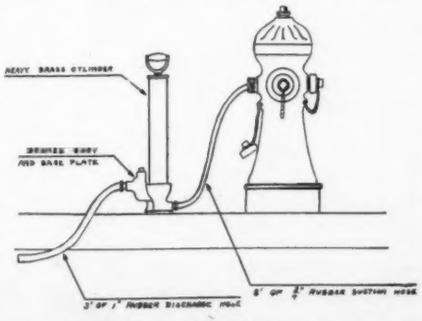
Parts Ready for Making a "Flexlock" Joint

Flexlock joints are now available for pipe size from 1½ inch to 36 inch internal diameter. For the illustrated bulletin, "Flexlock" Joints, address: U. S. Stoneware Company, or B. F. Goodrich Company, Akron, Ohio.

A New Hydrant and Utility Pump

EDSON CORPORATION, of Boston, Mass., are offering an improved hand pump for dewatering fire hydrants and for general utility use on water works and sewerage systems.

This light weight but durable pump of non-clogging design is constructed with bronze body and base plates to stand hard usage and abuse. It has a non-corroding heavy brass cylinder and is equipped with bronze ball checks which are readily accessible and non-corrodable. It comes equipped with an 8 ft. length of ¾ in. heavy wall suction hose and 3 ft. of 1 in. discharge hose. The former may be easily disconnected for use in routine hydrant inspection for water in the barrel by inserting the hose and drawing out to disclose the water depth, if any. The hose may be returned and the pump quickly connected for use if necessary, and at 20 strokes the hydrant is emptied.



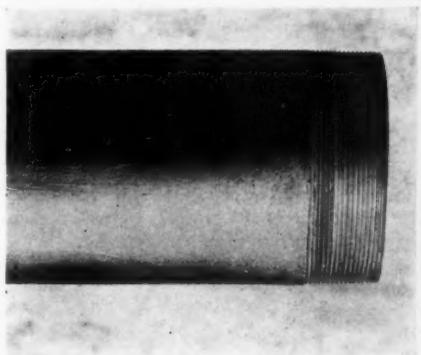
Edson Hydrant Pump

Seeing a genuine need for a light weight non-back-breaking hand pump which could "take it," Edson Corporation have developed a bilge salt-water pump into this improved pump for the utility truck tool-box, and for the man on foot. For further information and prices, address The Edson Corporation, 49 D Street, South Boston, Mass.

C. I. Pipe With Threaded Ends

United States Pipe and Foundry Company of Burlington, N. J., are now supplying toughened Super-de Lavaud Cast Iron pipes in steel pipe sizes *with threaded ends*. The pipes are designed for consumer service lines, use in buildings and factories for water, steam or gas and as drainage lines. They are offered in standard, extra strong and double-extra-strength weights to meet Federal Specifications WW-P-421 for water pipes and TS.-2068 for drainage pipes.

The new light weight pipes, with the properties of Cast Iron and adaptability of steel and wrought iron pipes, have been made possible through the Super-de Lavaud Centrifugal Process of production. This pipe, which is really machinable and workable with the average plumber's kit,



C. I. Pipe with Threaded Ends

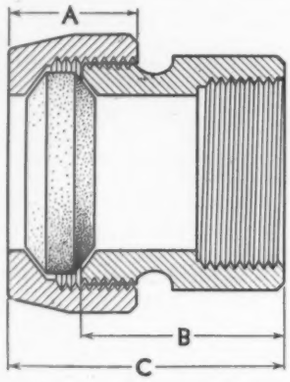
comes with American Standard Pipe Threads on each end and is coated inside and out with bitumastic paint. Plain and C. I. pipes and pipes of the nickel-cast iron alloy (Ni-Resist), to meet service conditions where corrosion is especially severe, can also be supplied with threaded ends.

For descriptive literature on Super-de Lavaud Threaded End Pipes, address: U. S. Pipe and Foundry Co., Burlington, N. J.

Neptune Slip-Couplings

Neptune Meter Company of New York City, are offering the Neptune-Adams Slip Coupling, especially designed to simplify and reduce time and labor required in installing or replacing water meters.

The Slip Coupling (see cut) consists of brass outer coupling nut, compression gasket, brass inner coupling nut, brass washer ring and composition gasket. The



Neptune Slip Coupling

inner coupling nut (B) screws onto the meter thread; the outer coupling (A), with the compression gasket or ring, slips over the unthreaded end of the service pipe and the two couplings are screwed together.

The value of a give and take friction type coupling is self-evident. It precludes threading of pipe or cutting of nipples to exact lengths. Allowing a full half inch leeway, it is of special value when working in hard-to-get-at places, in overcoming pipe "creeping," and to simplify meter replacements generally.

For a descriptive illustrated leaflet, with price list, address Neptune Meter Company, 50 West 50th St. (Rockefeller Center), New York City.

Cement Lined Pipe Co. Expands

The Cement Lined Pipe Company of Lynn, Mass., through its recently formed subsidiary--Public Works Supply Company—is now representing Worthington Pump and Machinery Co.; Crucible Steel Company of America; E. I. Du Pont de Nemours & Co.; Darling Valve and Mfg. Co.; and Ford Meter Box Company in northern New England.

Cement Lined Pipe Co. in another step of expansion, have opened their new plant at 61 Clinton Ave., Brooklyn, N. Y. The company is distributing a new and interesting booklet entitled "A Solution of the Pipe Corrosion Problem," copies of which may be had by addressing Cement Lined Pipe Co., Lynn, Mass.

C. W. East Made Assistant Sales Manager Pipe Division Republic Steel

Charles W. East, formerly of the Birmingham, Ala., office of Republic Steel Corporation, has been named Assistant Manager of Sales in Republic's Pipe Division, succeeding George E. Clifford, recently appointed District Sales Manager for Republic in the Los Angeles, Calif., territory. These appointments were recently announced by N. J. Clarke, Vice President in Charge of Sales, Republic Steel Corporation, Youngstown, Ohio.

Catalogs and Trade Literature Received

Jeffrey Water and Sewage Equipment: Jeffrey Manufacturing Company has just issued a 31 page catalog which illustrates and describes their complete line of conveyors, sludge collectors, screens and shredding mills for water works and sewerage systems. Included are the Jeffrey self-cleaning bar screens, screenings and garbage grinders, grit washers, and sludge collectors. Design features are outlined and installation views shown. For a copy of the new Calalog No. 615, address: Jeffrey Manufacturing Co., Columbus, Ohio.

Jeffrey Vibrating Feeder: The Jeffrey-Traylor electric vibrating-type materials handling and feeding equipment is described and illustrated in a new 64 page catalog. This line of equipment has no mechanical moving parts and depends on electrical vibrations to accurately feed or transport dry (flowing) chemicals such as are employed in water and sewage treatment. Ask for Catalog No. 610—address: Jeffrey Manufacturing Co., Columbus, Ohio.

"Anhydrous Ammonia"—A booklet bearing this title from Pennsylvania Salt Manufacturing Company contains in concentrated form much useful information on anhydrous ammonia with particular reference to its effective handling and use. Its physical and chemical properties are set forth with the aid of graphs for ready reference. Equipment and methods of handling and storage, and first aid measures are suggested. Ammonia users will find much of interest and value in this condensed treatise. Address Pennsylvania Salt Manufacturing Company, Widener Bldg., Philadelphia, Pa.

"Pyrex"—The Laboratory Division of Corning Glass Works, has recently issued a new catalog (with supplement) descriptive of their line of "Pyrex" Laboratory Glassware and Tubing. We understand that "Pyrex" glassware for laboratory use can now be ordered direct from the Corning Glass Works which the amply illustrated catalog, specifications, listed prices and directions for ordering will make possible. Every laboratory should have on hand a copy of "Pyrex Laboratory Glassware"; address Laboratory Division, Corning Glass Works, Corning, N. Y.

"Syntron Dry Feeders"—Are described in a new illustrated bulletin from Syntron Company of Pittsburgh, Pa. These unique chemical feeders *without moving parts* rely on electro-magnetic high frequency vibrations, adjustable to the required amplitude. An extremely wide range of output is covered—½ lb. of carbon to 11 tons of pebble lime per hour being shown in the "Specifications and Capacities" listed. Remote control and intermittent feeding is made possible through the calibrated control panel. Address Syntron Co., 400 N. Lexington Ave., Pittsburgh, Pa.

"Electric Equipment for Water and Sewerage Works"—A brochure from General Electric Company presents numerous illustrations of pumping and switchboard installations at water works and sewage plants in America. In presenting typical examples of modern pumping and sewage disposal stations, they also offer assistance of the G. E. technical staff in planning improvements to existing stations or construction of new ones. For a copy, address General Electric Company, Schenectady, N. Y.

"Portable Electric Welders"—From the Lincoln Electric Company comes a bulletin describing Lincoln "Shield Arc" Welders including illustrations and specifications. At this season, of approaching winter, information on portable welding equipment for the double duty of pipe and main thawing and welding operations may be timely. For literature on "Portable Electric Welders" address Lincoln Electric Company, Cleveland, Ohio.

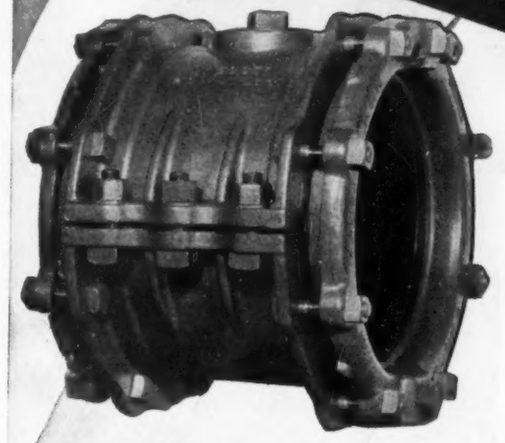
"Everson Chlorinators"—Bulletin No. 768-B. describes and illustrates three models of Everson Chlorinators with ranges of a few ounces to 20 lbs. of chlorine per day. Bulletin 703 describes Everson Water Testing Outfits and chlorinating chemicals supplied. For copies of each, address Everson Filter Co., 627 West Lake St., Chicago, Ill.

"Morris Centrifugal Pumps"—Is a new bulletin issued by Morris Machine Works (pioneer manufacturers of centrifugal pumps), which lists and pictures the many types and designs of the full line of Morris Pumps, for a variety of service from dredging to water pumping. This new bulletin, intended as a reference and guide book, contains useful information to centrifugal pump users. For a copy ask for Bulletin 157, address Morris Machine Works, Baldwinsville, N. Y.

"The Air Lift"—Is the title of Ingersoll-Rand's new 24 page bulletin which discusses the principles, theory, adaptations and advantages from the air lift method of pumping water and other liquids for certain conditions. Terms, formula and data used in air lift pumping computations and design are included and applications illustrated. Ask for Bulletin 9042; address Ingersoll-Rand Co., 11 Broadway, New York City.

"Chemical Pumps & Valves"—Is the title of a borchure describing Hills-McCanna corrosion proof (Saunders) valves, centrifugal chemical pumps and chemical proportioning pumps especially adaptable to use in plants employing highly corrosive chemical solutions such as ferric chloride, chlorinated iron and the like. Anyone interested in the use of ferric salts in water treatment should request a copy. Address Hills-McCanna Co., 2349 Nelson St., Chicago, Ill.

THERE GOES ANOTHER PIPE BREAK!



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On other pages in this issue you will find described new and improved equipment, etc., as well as reviews of recent trade literature received by us. By requesting the literature described you will be able to keep your catalog file complete and up to date.

To our readers desiring additional help or information we will be glad to assist you in securing more complete information or data on any equipment or product you need. Use the convenient blank below — No cost or obligation.

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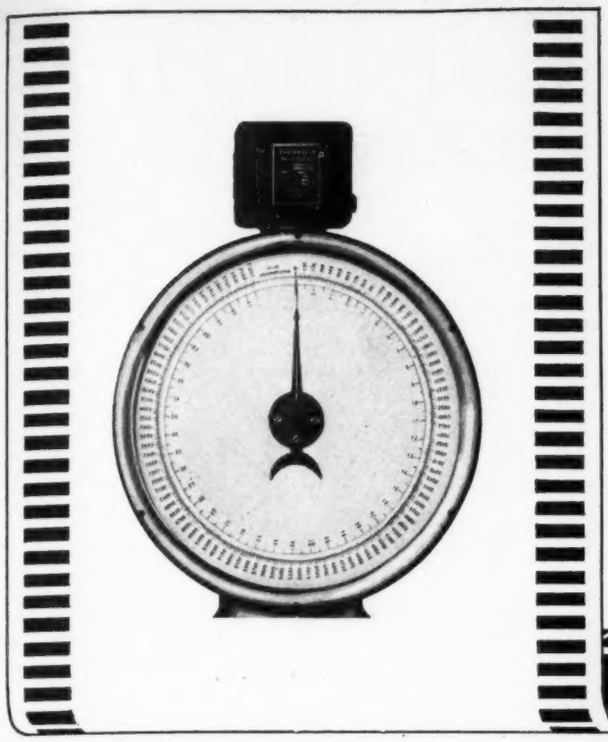

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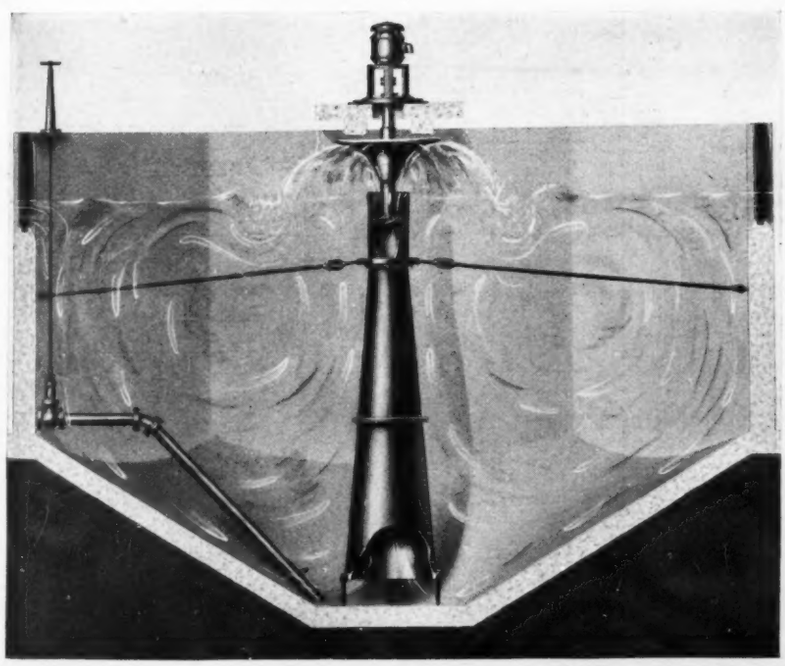

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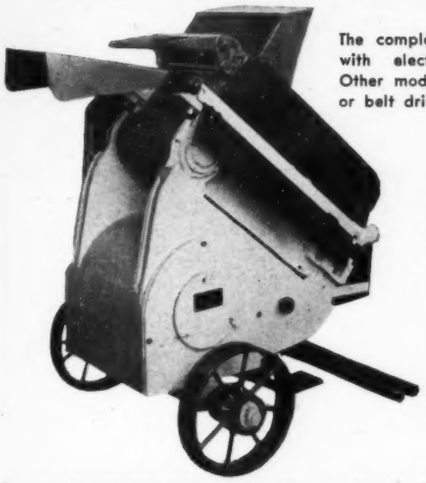

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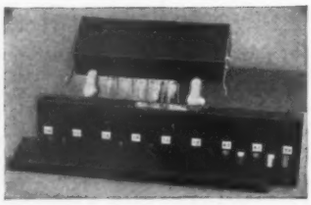

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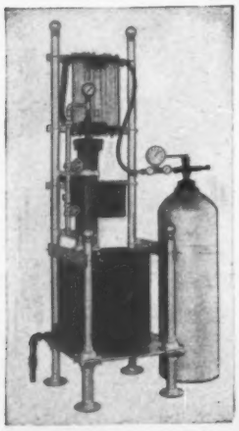

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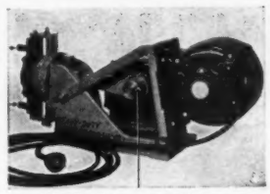

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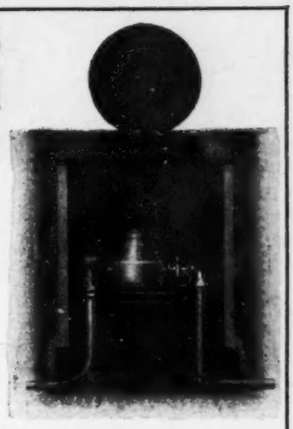

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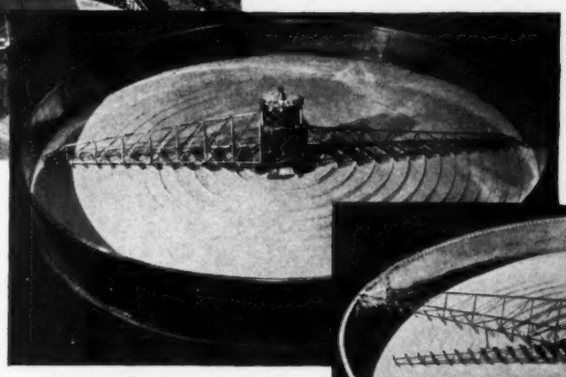
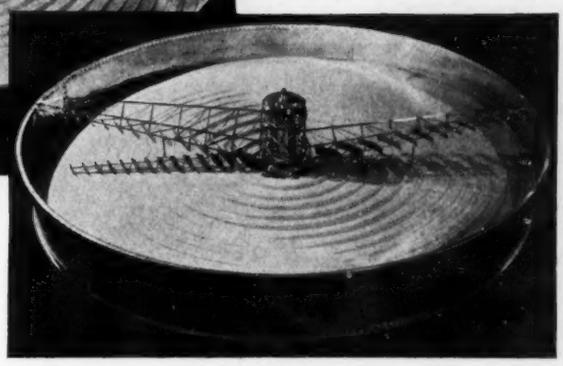


Above — Scale model with rake arms in normal operating position.



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